THE

# ELECTRICAL REVIEW.

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## THE HAMPSTEAD FATALITY.

THE indulgence with which the Board of Trade habitually regards electrical enterprise rather tends to accentuate the severe terms in which Major Cardew reports on the recent fatality at Hampstead. The facts relating to the accident have been already given in a previous issue of this Journal, and are set forth with preciseness in Major Cardew's report, which appears in another part of the present issue. It will be remembered that one of the Hampstead Vestry's workmen, named White, while descending a ladder into one of the transformer chambers, put one foot on the flat top of a transformer case, which was evidently charged to a high potential from earth, with the result that the man received a fatal shock. There is little doubt that the transformer chamber in which this accident occurred must have been exceedingly restricted in size; indeed, this fact is commented upon by Major Cardew, and we are much afraid that engineers have been in many cases somewhat prone to make their sub-stations of the smallest possible dimensions. There must of necessity be always an element of danger in a transformer, but it would scarcely appear that this had been recognised in the Hampstead case, or it would have been impossible for anyone when descending the chamber to have come into contact with the transformer.

It is clear from the report that the smaller details of the transformer chamber show a marked absence of care in their arrangement. The two principal faults were, that the only earth (!) connection made was to an iron bolt let into the wall of the chamber, and that the holes in the transformer case through which the wires passed to the high pressure terminals were not bushed by an insulating material. Consequently, when the insulation of the leading-in wires became faulty, the case of the transformer was charged to a high potential from earth, and the means whereby such a dangerous condition could have been obviated, a good connection to earth, did not exist, with the consequence that the person who next came in contact with the case became the sufferer. Major Cardew has already shown to what extent the Board of Trade rules have been transgressed, and it is not for us to labour the point. There seems, however, to have been a curious misconception at Hampstead as to what makes a good earth, that is, if one may take the iron bolt referred to by Major Cardew as seriously intended to form connection with earth.

To take the antiquated institution of lightning conductors a test would be considered unsatisfactory even in a dry season unless, including the whole conductor *and the earth* resistance, they gave *less than one ohm!*

Even in telegraphy, copper sheets $5\frac{1}{2}$ feet by $2\frac{1}{2}$ feet are used, and in telephony a water pipe in direct connection with the main, or a gas pipe in the supply side of the meter should for preference be employed even for the minute currents necessary to actuate the receiver. For high

pressure electric lighting why should not the lightning conductor specification that the "earth" should be a copper plate not less than 6 feet square (not 6 square feet) embedded in coke, moist earth, or in a well, *soldered* to the water pipes, or preferably bolted to the water mains, be brought into service in at least some of its provisions? Of course, much of this would be rendered unnecessary if the armouring of the cable were used in the manner prescribed in the Hampstead Order.

It is to be hoped that central station men as a body have a better conception of what earth means than is indicated above. For instance, a connection to any piece of metal which may be perfectly isolated, for all one knows, should not be considered as earthing the circuit, and tests to ascertain the actual condition of the earth connection should be frequently carried out. Stringent Board of Trade rules and regulations exist for the safety of those having to deal with high tension appliances, but these are not made to be ignored. We have not the least desire to exaggerate the dangers of transformer systems, nor do we think that the regrettable accident at Hampstead constitutes an argument against alternating current practice, because we are confident that a system could be designed which would be safe under all conditions.

In electrical work the most serious dangers are those which are not obvious. The most ignorant man recognises the danger in a revolving piece of mechanism, but it is not so easy to appreciate the deadly danger that lurks in switch gear and transformers, and in these cases it is of the highest importance that no effort should be spared to make them perfectly safe. It may cost more in the first instance, but compared with the value of human life it is a cost that can be justifiably incurred.

## "THE DEFENCE OF THE EMPIRE."

Under this title, an interesting selection from the letters and speeches of the late Earl of Carnarvon has just been published. As a Secretary of State for the Colonies, and also as President of the "Royal Commission for the Defence of British Possessions and Commerce Abroad," the labour of which extended over nearly three years, Lord Carnarvon had before him a mass of important evidence which, for obvious reasons, has not been made public. That the impression made upon Lord Carnarvon's mind by the knowledge which he acquired was strong and vivid, is shown on every page of the book; and, as Sir George Clarke points out in his preface, "to Lord Carnarvon belongs the honour of earnestly endeavouring to supply the sustained impulse, failing which, little would have been accomplished. And when, in the future, historians come to examine the causes which led to the transformation of a condition of extreme national peril into one of comparative security, his devoted services to the Empire will be gratefully acknowledged." The letters and speeches which have been selected to form this volume are almost entirely in reference to the establishment and defence of coaling stations, and the ports in the Colonies; but it must not be supposed from this that Lord Carnarvon was blind to the important part which submarine telegraph cables must occupy in any scheme of Imperial defence which pretends to be at all adequate. We think that the warning conveyed in his words to the House of Lords, in a speech made on April 14th, 1885, are worthy of repetition, and might with advantage have appeared amongst the selection. Space will not, however, allow of more than a short extract. In a discussion raised by a question drawing attention of Her Majesty's Government to the fact that the "sole method of telegraphic communication with Hong Kong and some other British settlements in the East was by wires passing through a territory in the possession of a foreign Power, and whether it was the intention of Her Majesty's Government to adopt immediate measures to insure the safety of intercourse by electric telegraph with those parts." Lord Carnarvon said: "The matter was a delicate one, but he thought it right to remind the House and the country that in 1878 when there were great alarms as to a Russian war, the Russian Government, who were perhaps more alive to the circumstances of the case than we were, had taken measures for cutting the submarine cables and for equipping ships for that special purpose. It was said at the time, and on good authority, and was generally believed, that there was a carefully elaborated scheme for taking measures against our submarine cables in the Eastern waters. It was quite right to mention these matters now, and he trusted that the Government had not been blind to the danger of leaving them unprovided for, but that while they had had the opportunity and a full warning, they had taken those steps and those measures which might be necessary at any hour."

The political outlook to-day is similar in many respects to that existing at the time referred to in the above remarks, and yet we are little, if indeed at all, nearer to a position of safety as regards telegraph communication than we were then. Under such conditions it was, to say the least, disquieting, to know that the only two direct cables between Malta and Alexandria were simultaneously interrupted a fortnight ago, the Eastern Telegraph Company announcing that telegrams for Egypt by their cables suffered delay; and communication was not restored for about a week. In a time of international complications such as the present, it is not at all reassuring to call to mind that in event of the two cables between India and Egypt being interrupted, our only reliance for news to or from India, China and Australia, must be placed on landlines, one of which passes through Persia and Turkey, &c., and the other across Siberia and Russia. In reference to one of these routes we may, perhaps, be allowed to quote from a note which appeared some time ago in these columns. "The Russian Telegraphic Administration has informed the directors of the Indo-European Telegraph Company, Limited, that the latter will not in future be permitted to fill up vacancies which occur in the company's Russian stations with English operators; telegraphists from the Russian service are to be recruited for this purpose."

With such knowledge available, it is astonishing that no effective means have as yet been taken to place beyond danger our means of assured telegraph communication between England and her Eastern and Australasian possessions.

## OVERHEAD TROLLEY CONSTRUCTION IN THE UNITED STATES.

In a recent "Electric Traction Note," some mention was given in our columns of the latest electric lines installed at Richmond (Virginia); and the remark was then made that the current American usage in regard to overhead feeders appeared to be such as would never be sanctioned in this country—we certainly hope not, at least.

Much the same comment is to be passed upon the plans and methods described in Mr. Benjamin Willard's paper upon "Modern Overhead Trolley Road Construction," read before the American Street Railway Association, and which has been reprinted in *Cassier's Magazine*. The illustrations appended to this article nearly all show heavy wooden poles, carrying from 10 to 20 or 30 enormous overhead feeder cables, and this system of supply is everywhere dealt with as standard. We may well feel profoundly grateful to a Board of Trade for preserving us from such methods—at any rate, in ordinary street tramway work. It is, indeed, terribly hard work to persuade a more or less intelligent and would-be æsthetic people that trolley wires, when properly erected, are not an absolute disfigurement of dingy streets any more than broad boulevards. What the task would be to advocate or propose the erection of wooden poles and heavy overhead feeders along main thoroughfares, we refrain from trying to imagine. It surely is but a question of time as to how long public feeling in the States will sanction the use of overhead feeders, at any rate, along the chief streets of a town, whatever may be done in the country. We should, however, feel inclined to object even to the latter, and if any scene is to be spoilt, to let it be that made by man and not by nature.

Mr. Willard's paper deals very largely with the comparison in cost, &c., between steel and wooden poles, and the fact that steel poles do thus enter largely into consideration offers a ray of hope that by-and-by wooden structures will vanish. Doubtless in a new country the element of cheapness alone will ensure the use of timber for a long while; but even Mr. Willard's figures do not show a very marked economy in favour of wood, though his inclination leans evidently in that direction. He gives to steel and wooden poles respectively, lives of 30 and 12 years; and there seems no great reason for saying that either of these is too high, certainly not the former. Cost, of course, varies considerably; steel span wire poles are estimated at as little as £3 each—which would seem too low to a strength and substance-loving Englishman.

Mr. Willard enters upon a very curious calculation in arriving at the comparative total cost of steel and wooden poles; although assuming the life of the former is 30 years as stated, he allows 5 per cent. per annum as interest on the capital outlay (an investment to be jumped at now-a-days!); but if, for instance, an English municipality were incurring the capital expenditure, 5 per cent. should be almost enough to cover interest, depreciation and sinking fund, so that the poles would all be paid for, and the outlay wiped out long before the 30 years had expired. Yet Mr. Willard adds on the 5 per cent. per annum for 30 years in order to get the total cost, though, of course, the interest amounts to half as much again as the first cost of poles.

The cost of setting, inclusive of concrete, &c., is stated to be about 18s. per pole for steel poles; when wooden ones are employed, he considers that concrete is unnecessary, as a rule, though of course a great deal depends upon the nature of the subsoil. At any rate, the cost should not then exceed 10s. per pole. The wooden poles themselves may be averaged out at 18s. to 20s., lasting, as stated, for at least 12 years.

It should be said that for steel span work, Mr. Willard specifies a pole of about 700 lbs. weight in *two* sections only, 6-inch extra heavy, and 5-inch standard, swaged at the joint for 18 inches. The lower section is 18 feet long, and the upper 10 feet; the whole set 6 feet in the ground with a rake of 10 inches. Such a pole, while well set, seems to us rather light even for span work; and a three-section pole might in many cases be more preferable. However, this is naturally a question of capital expenditure in regard to repairs and renewals.

It seems hardly worth while touching upon the specification for wooden poles; unless very briefly as a matter of comparison with telegraph work. The type recommended by Mr. Willard averages 30 feet long, sawn square, 11 inches at base, 7 inches at top; long leaf yellow pine is usually employed; the corners chamfered off 1½ inches. A rake of 12 inches is ordinarily given.

The following table embodies the chief characteristics of Mr. Willard's specifications for poles; and it may be of use to English engineers for purposes of comparison:—

Steel Poles.

| Purpose. | Length in all. | Shape. | No. of sections and size. | Weight. lbs. | Length in ground. | Rake. |
|---|---|---|---|---|---|---|
| Span ... ... | 28 ft. | Pipe | 18 ft. of 6 in.<br>10 ft. of 5 in. | 700 | 6 ft. | 10 in. |
| Curve: centre pole: side bracket. | 29 ft. | " | 19 ft. of 7 in.<br>10 ft. of 6 in. | 1,050 | 7 ft. | 10 in. |

Wooden Poles.

| | | | | | | |
|---|---|---|---|---|---|---|
| Span ... ... | 30 ft. | square | diminished from 11 × 11 to 7 × 7 | ... | 6 ft. | 12 in. |
| Curve, &c. ... | 31 ft. | " | ditto 14 × 14 to 9 × 9 | ... | 7 ft. | 12 in. |

Mr. Willard prefers span work to the use of centre poles, owing to the greater flexibility of the former, besides which, it is *less unsightly!* We fancy that most will disagree with him on the latter point at any rate. He is quite right as to the superior qualities of the span wire system for regular hard work; it is in reality by far the strongest and most mechanical system of stringing trolley wires; but certainly it is much more unsightly than centre pole construction.

There is nothing much else to comment upon in this paper. Mr. Willard rightly praises the flexible bracket suspension; says that span wire should be of steel, $\frac{5}{16}$-inch diameter, of seven strands No. 12 galvanised wire, set up with a strain of about 750 lbs., and advocates for general use the plain round trolley wire instead of the pear shaped, or figure of eight section. The goose-neck hanger he thinks best on the whole for curve work, and lightning arresters ought to be fixed at least every half mile. The paper, generally, is worth reading *in extenso* by those who take an interest in traction matters.

## THE ECONOMICS OF ELECTRICAL TRANSMISSION OF POWER.

In a recent paper read by Mr. Walter Dixon before the West of Scotland Iron and Steel Institute, the author points out that iron and steel works have, so far, rather neglected electrical driving, but the example to-day of the New Duquesne Steel Works, of America, which have adopted the new system, is likely to make for a different condition of affairs in the near future.

Mr. Dixon has recently examined in detail electric power plants of nearly 50,000 H.P. on the Continent, including probably four-fifths of those which have formed subjects of papers, or received notice in various British Institutions. In America it is estimated there are 500,000 motors in 10,000 installations, and some 15,000 H.P. in New York City alone. In England alone there is slackness in this new driving, and even the machinery for the utilisation of the Falls of Foyers was made abroad in an electrically driven workshop. A newly arranged works on the Continent has recently cut us out in certain markets, largely because of its reduced driving costs, and when a single works can save £3,000 a year by electrical driving, is it not time to begin to do something else than theorise upon the chances.

The methods in most general use in iron works are at present: (1) The use of large centrally placed engines transmitting power by the means of shafting, belts, ropes, &c., to the various closely contiguous departments, and (2) the carrying of steam in pipes to small engines placed near to the department to be driven. Not much can be said for either of these systems we imagine, and but little of the energy

generated will appear at the point of distribution. Flather gives the power to drive shafting as from 15 to 80 per cent. of the total engine power, and an average in 10 cases of 38·6 per cent. If any of our readers have a place driven by a gas engine, they may for themselves easily obtain an approximation to the proportion of power used by machines, and by the gearing of transmission. A gas engine is particularly useful in this connection. It may first be run unloaded, and the explosions counted during a period of four minutes or thereabouts. At once then is known the number of units, as we may term an explosion. Cannot the professors find a new term for this unit? Then the increase of the number of explosions in the same time when driving the shafting, the further addition for each machine also in the same period of time, enable the proportion of power absorption to be at once obtained with probably better accuracy than any number of indications.

Moreover, the absorption of power by the shafting goes on as long as the engine runs, even when only a single machine is being driven. Mr. Richardson, Mr. Westgarth, and Mr. Adamson, who have all investigated the subject, concur in the opinion of the large proportion of engine power which is consumed uselessly. Turning to the second system, that of scattered steam engines, it is obvious that such cannot be of economical type, nor can they be so well looked after as larger central engines. They must be supplied with steam surely of great wetness, and the various losses by cooling, leakage, &c., must be and are enormous. In one estimate the coal per I.H.P. is 177 lbs. per hour; other cases show over 55 lbs. of steam per I.H.P. hour, and generally extreme wastefulness characterises all existing systems of mechanical types. Mr. Dixon gives the efficiency of electrical plant at half and at full load as follows:—

Generators, 83 to 92 or 94 per cent.; conductors up to 400 yards, 98 to 93 cent.; small motors up to, say, 10 H.P., 78 to 85 per cent.; large motors, 88 to 92 per cent.; and the combined total efficiency, 67 to 72 per cent. With engines of 20 lbs. steam per hour type, the coal per I.H.P. will be 27 lbs. at half load, and 25½ lbs. per full load, or 36 and 34 lbs. respectively per actual horse-power in small motors. But apart from this is the fact of the facility of starting and stopping electric motors, and the fact that a motor is in a sense its own governor. It only puts out the power demanded from it. The five points we may therefore note in old methods are the large capital expenditure upon plants of double the necessary size, the excessive coal consumption, heavy charges for handling fuel, additional attendants, excessive repairs and maintenance.

In electrical work these items are reduced to a minimum, and no coal is burned uselessly. In a case cited in the north of England, where a 40-H.P. installation cost £1,000, the cost was saved in 12 months in fuel and wages. The author, who has gone carefully into the question for several large works, states that old steam-driven machines can readily be adapted to electrical driving; shears, saws, live rollers, travelling tables, cranes and elevators, as well as machine tools, all lend themselves readily to the change. A case in point involves the replacing of 39 engines by 39 motors. The cost of this would be approximately £9,000 for a power of 500 H.P. in generators and 400 H.P. in motors. This latter if run 300 days of 24 hours, the steam costs would be at, say, 20 lbs. of coal per H.P. hour with coal at 4s. per ton, £5,140. With electric plant and 6 lbs. of coal per H.P. hour, the cost would be £1,542 per annum, or £3,500 saved. In new works the item of first cost is of no importance, for the introduction of electrical plant does not then throw any old plant upon the scrap heap. But with electricity there is no call for heavy brick walls to carry power appliances, and motors may go anywhere most convenient. Large machines may have separate motors, especially if only used occasionally. The interference of shafting is avoided. Machines may be fixed at their best positions, and may be run at any speed. First cost may be less than that of ordinary plant. Mr. Siemens finds the newer plant costs 30 per cent. less than the old system plant. The case is plain enough, but even where people have the money to spend, it is difficult to persuade them to make a change, even when the outlay may be returned in a year. In a case which came under the writer's own notice—not an electrical case—three years were consumed in persuading a man to the undertaking of an economy which, when finally carried out, proved to be saved out of the first three or four months' earnings. Repeated instances of this kind are coming before engineers every day. It is the hardest thing in the world to persuade a man to effect an economy.

When the exhaust steam injector was first brought out many steam users would not use it, because they "could not see how exhaust steam could be made to force water against a higher pressure." Yet these same unbelievers would use a geared crab to raise a ton weight. They would doubtless have talked about leverage and believed they understood it, or they would not hesitate to buy an expensive hydraulic press which they believed they understood. As a fact, these unbelievers know nothing, nor can they grasp a principle or understand an explanation. There are thousands of steam users to-day who smell of money and want more, yet you cannot teach them they would save by the adoption of electrical driving. They are the brakes on the wheels of progress. Like the poor they are always with us, and a heavy load they are.

## ON THE MECHANICAL CONCEPTIONS OF ELECTRICITY AND MAGNETISM.

We welcome the appearance in the *Physical Review* for March-April of this year of a paper by W. S. Franklin, bearing the above title, and which, while admittedly based upon the conceptions of Maxwell, and following in some particulars the work of Lodge, gives a clearer and more consistent mechanical picture of electrical and magnetic phenomena than we have yet seen. We have become familiarised in the writings of Lodge and others with the conception of an ether constituted of wheels or cells gearing into one another, and capable of certain rotations and strains, and it is certain that to most of us some such mental picture of the field of electric and magnetic force is an absolute necessity, if we are to attempt any co-ordination of known facts. Our pictures may be at present but caricatures of the ultimate truth, approximations, let us say analogies, of the crudest kind, but they constitute a starting point; they form the embryo of a theory which, when fully developed, may lead to the actual truth, and what is of immediate practical importance, they enable us to co-ordinate our ideas and think connectedly on these questions in a way we cannot do without their help. "If we resist the help of an analogy like this, there are only two courses open to us: either we must become first-rate mathematicians, able to live wholly among symbols, dispensing with pictorial images and such adventi-

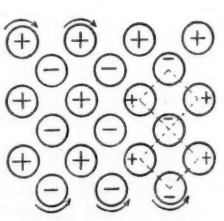


Fig. 1.

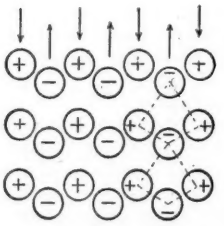


Fig. 2.

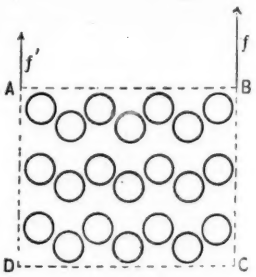



Fig. 3.

tious aid; or we must remain in hazy ignorance of the stages which have been reached, and of the present knowledge of electricity so far as it goes." (Lodge, "Modern Views," Chapter I.)

The author supposes, with Lodge, that the ether is built up of *positive* and *negative* cells in such a way, that only unlike cells are in contact. The cells are so connected, when in contact, that if one cell is turned while adjacent cells are kept stationary, an opposing torque, proportional to the angle turned, is brought to bear upon the cell, which tends to right it. In a magnetic field the cells are supposed to be rotating about axes parallel to the lines of magnetic force,

their angular velocity being the measure of the field intensity. The negative cells act as intermediate gear wheels for the positive cells, and conversely. In fig. 1 the magnetic field is perpendicular to the paper; all the positive cells are rotating clockwise, and the negative cells counter-clockwise. The energy per unit volume is proportional to the square of the angular velocity, *i.e.*, to the square of the field intensity.

In an electric field we again suppose with Lodge that a kind of shear takes place, a displacement of positive and negative cells in opposite directions, such displacement being proportional to the field intensity. Fig. 2 shows the positive cells displaced towards the bottom of the page relatively to the negative cells. The amount of strain energy per unit volume is proportional to the square of the displacement, *i.e.*, to the square of the field intensity.

Considering one of the negative cells, say in the middle row of fig. 2, we see that the downward displacement of the positive cells on the right hand side will exert upon it a clockwise torque proportional to the displacement, *i.e.*, proportional to the electric force, while the displacement of the left hand cells will produce an opposite torque, which will be of equal amount if the electric field is uniform, but not otherwise. This leads us to the explanation of induced electromotive force. Consider a closed boundary, A B C D (fig. 3), in a plane normal to the magnetic field. The lines D A, C B of equal length, $l$, are in the direction of the electric force. The force along D A is $l f^1$, and along C B is $l f$.

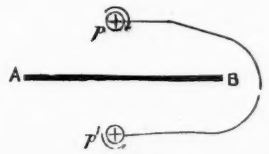



Fig. 4.

The total torque acting upon the cells within the area, and which is proportional to their total angular acceleration, *i.e.*, to the *rate of change* of the whole magnetic field, is proportional to $l f^1 - l f$, which is the resultant electric force round the boundary.

In a somewhat similar manner the magneto-motive force round a closed curve is shown to be proportional to the rate of change of the electric flux.

The transmission of energy will be from right to left, or conversely, of each of the chains of cells in figs. 2 or 3, and the rate of transmission from one cell to the next will be proportional to the product of the torque action into the speed, *i.e.*, to the product of electric into magnetic force. The energy stream is thus at right angles both to the magnetic and electric field.

The electric current is regarded, as in "Modern Views," as the result of *slip* between the adjacent ether cells. If A B (fig. 4) is a wire conveying a current, the positive cells

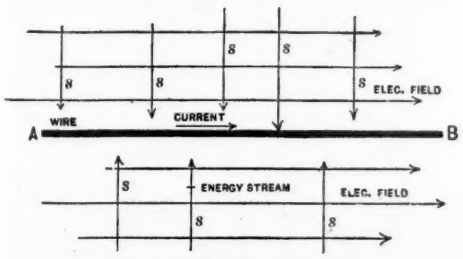



Fig. 5.

are rotating in opposite directions on the opposite sides of A B. Considering two-dimensioned space only—we are liable, sometimes, to meet with certain inconsistencies in translating these conceptions into three-dimensioned space—we see that slip must take place at some point along every line connecting the cells, $p$ and $p^1$, in order for these opposite rotations to be possible. Thus the electric current, or *the locus of the points of slip*, must be a closed circuit. If a current flows along a circuit which is not closed, an increasing ether-distortion is produced around the end portions of the circuit, which constitutes electric charge there.

The field in the neighbourhood of a straight wire is represented by fig. 5. The magnetic field circles round the wire; positive cells rotate in opposite directions on the two sides of A B, and the necessary slip goes on in the wire. The electric field, whose intensity is proportional to the potential-gradient along the wire, is parallel to the latter. The energy stream, as stated, is at right angles to both fields, as indicated by the arrows $s$, and is directed towards the wire from all sides. The energy streaming in appears as heat in the wire, the rate of production of heat being proportional to the product of the electric and magnetic fields, *i.e.*, to the product of volts per centimetre and current.

In order to explain the equation $E = l f v$, expressing the electromotive force induced in a wire of length $l$, moving at velocity $v$, across a magnetic field of intensity $f$, the author proceeds as follows:—Let the line A B (fig. 6) be a line of force

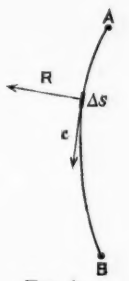



Fig. 6.

of an electric field, and imagine the whole region about A B to be a uniform magnetific field perpendicular to the paper, and of intensity $f$. The energy stream, R, at $\Delta s$ is normal to $\Delta s$, and proportional to the product of the intensities of the electric and magnetic fields at $\Delta s$; that is, $R = k f e$, where $k$ is a constant, and $e$ is the intensity of the electric field at $\Delta s$.

The energy per second crossing $\Delta s$ (unit depth) is $R \Delta s = k f e \,.\, \Delta s$, and the energy per second crossing the entire line A B is $\Sigma k f e \Delta s$, or $k f \Sigma e \,.\, \Delta s$, but $\Sigma e \,.\, \Delta s$ is the electromotive force along A B. Therefore, *the energy per second crossing* A B *is equal to the product* $k f$ E, *where* E *is the electromotive force along* A B.

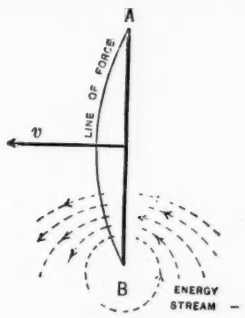



Fig. 7.

Let A B (fig. 7) be a rod of length $l$, and of unit width perpendicularly to the plane of the paper, moving at velocity $v$ across a magnetic field of intensity $f$, perpendicular to the paper. The magnetic energy $\frac{1}{8\pi} f^2 l v \Delta t$, which resides in the space $l v \Delta t$ (unit depth), which is swept over by the rod during $\Delta t$, must be equal to the energy $k f E \Delta t$ which streams across the *line of force* during that interval. That is, $\frac{1}{8\pi} f^2 l v \Delta t = k f E \Delta t$, or $E = \frac{1}{8\pi k} l f v$. By properly choosing the unit electromotive force, we may provide that the factor $\frac{1}{8\pi k}$ be equal to unity, in which case we have $E = l f v$. Further, when $\frac{1}{8\pi k} = 1$, then $k = \frac{1}{8\pi}$, so that the energy stream at a point in an electromagnetic field is $R = \frac{1}{8\pi} f e$, in which $f$ and $e$ are the in-

tensities in "electro-magnetic" units of the magnetic and electric fields at the point.

The conditions which accompany the charge and discharge of a condenser are explained in the following way:—In a row of gear wheels, A to B (fig. 8), if the wheel, B, is held

Fig. 8.

stationary while A is turned clockwise, a kind of zig-zag displacement will ensue, as in the figure. Such distortion, which, as we have seen above, constitutes electric strain, will be relieved if rotation or slip is permitted at any point in the row. This is precisely what takes place in condenser discharge (fig. 9). The horizontal rows of cells are distorted

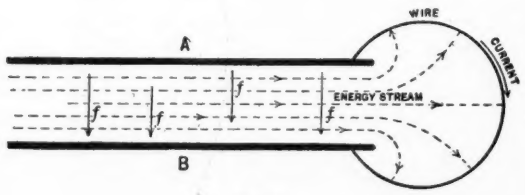



Fig. 9.

in the manner described owing to the electric strain, and a wire connected across A and B constitutes a line of slip which allows of the rotation of the cells and relieves the strain. If the slip in the wire is almost frictionless, that is if the resistance be low, the cells, when allowed to rotate, will overpass the normal position and produce an electric strain in the opposite sense, which will again be relieved by slip, a series of reversals thus taking place, giving the phenomenon of the *oscillatory discharge*. These oscillations will not take place if the resistance to slip in the wire is very great, as the cells will then slowly return to the normal position.

The author finally gives a picture of the Hertz vibrator, as seen in fig. 10. The above described phenomenon of the

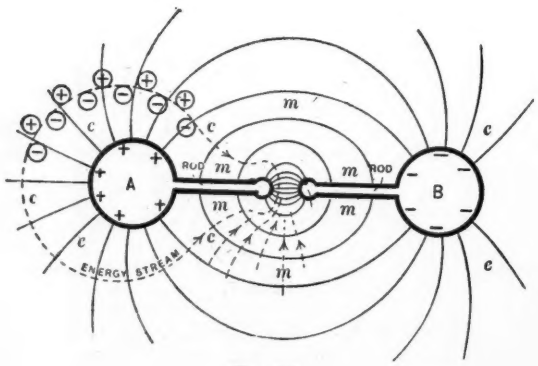


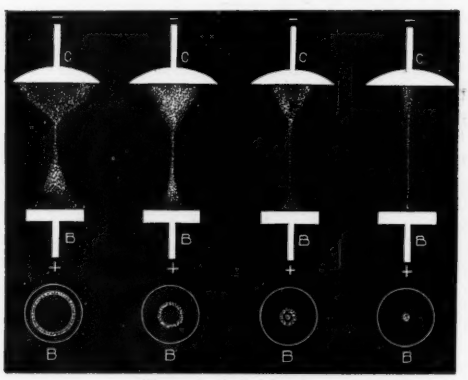

Fig. 10.

oscillatory discharge takes place, any closed chain of cells, *c*, having its distortion relieved by slip in the spark gap. The energy streams to a large extent towards the region, *m*, *m*, while the rotatory motion of the cells is reaching its maximum, streaming back again to the regions, *e*, *e*, while the reverse distortion is taking place. The oscillatory changes take place so rapidly that the portions of the ether remote from A B do not follow the changes promptly. At each charge of the balls a wave of electric force will be propagated outwards, while during the intervening periods of cell rotation waves of magnetic force will be set up perpendicular to them. The radiated waves thus consist of mutually perpendicular electric and magnetic fields. Stationary wave trains can, of course, be produced by the interference by reflection of such waves.

## MR. SWINTON ON CATHODE RAYS.

Mr. Swinton's paper read before the Royal Society on March 11th reveals some interesting and unexpected properties of the cathode rays as developed in the focus tube generally employed for the production of Röntgen rays. It would be difficult or impossible to explain all his results by means of any of the theories of the cathode rays at present in vogue, and Mr. Swinton wisely refrains from the attempt.

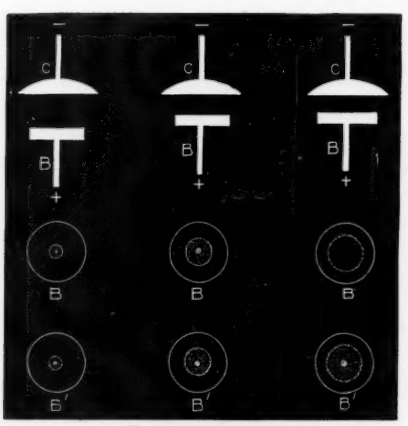
Mr. Swinton has discovered that electric light carbon is an excellent material for testing the distribution of energy in the cathode beam. When a concentrated stream of cathode rays is focussed upon a surface of carbon a very brilliant and distinctly defined luminescent spot appears on the surface of the carbon, and if the cathode beam is rapidly deflected by a magnet the spot moves about without any perceptible lag. By placing a carbon button at different distances from the




Figs. 1, 2, 3 and 4.

concave cathode disc in a focus tube, Mr. Swinton has been able to discover the distribution of radiant energy in the cathode beam on both sides of the focal point.

The tolerably well-known appearance of the cone of cathode rays as the vacuum in the tube increases is shown at C, C, C, C, figs. 1, 2, 3, 4. When the vacuum is not too high the rays which come off normal to the surface of the concave cathode converge to a focus, and diverge again immediately on the other side of the focus as shown in fig. 1. As the vacuum increases the rays after meeting at the focus appear to be unable to diverge immediately, but travel some distance together in a thin line, before divergence takes place. The length of this line gradually increases as the vacuum increases, as shown in figs. 2, 3, and 4.




Figs. 5, 6 and 7.

When the carbon button, B, was placed in the divergent cone, the unexpected discovery was made that the active rays were confined to the surface of the cone, a luminescent ring, as at B, fig. 1, being produced on the surface of the carbon anti-cathode. As the vacuum was increased, this ring contracted in diameter till at the highest vacuum it was reduced

to a luminous point. In fig. 3, it may be observed that a luminous point appears in the centre of a ring. The diameter of the luminescent ring may be increased or diminished, or finally reduced to a point, without altering the degree of the vacuum by moving the anti-cathode away from, or towards, or finally into the focus of the cathode stream; the appearance of the ring in each of these cases being practically similar to those shown in the figures for a uniform distance with varying vacuum. When the anti-cathode surface is not at right angles to the line of the discharge, the ring, in place of being circular, takes the form of a conic section.

It was found to be a much more difficult matter to investigate the distribution of radiant energy in the convergent code of cathode rays, but Mr. Swinton finally succeeded in proving that a similar surface concentration existed in this case, at least with short cones and moderate vacua. The diameter of the luminescent ring was not in this case affected by the degree of the vacuum; and, generally, there was a slight internal luminescence and a bright central spot. Figs. 5, 6, and 7, show the appearances on the face of the anti-cathode, B, at three different distances from the cathode disc, C. The series B, B, B is obtained, with a higher vacuum than the series $B^1$, $B^1$, $B^1$.

Mr. Swinton next describes experiments made to determine whether the rays crossed at the focal point, and also to discover whether there is any twist on or rotation of the rays, such as that observed by Birkeland (Electrical Review, June 22nd, 1896), when the rays were focussed by a magnet. In one of these experiments he cut a sector, amounting to one-eighth of the disc, out of the cathode, C, fig. 9, and placed the carbon anti-cathode, B, in the divergent cone of rays. A most unexpected result was obtained. The luminescent ring, which ought to have been seven-eighths of the circumference, was found to have shrunk to about one-eighth, much

Fig. 9.

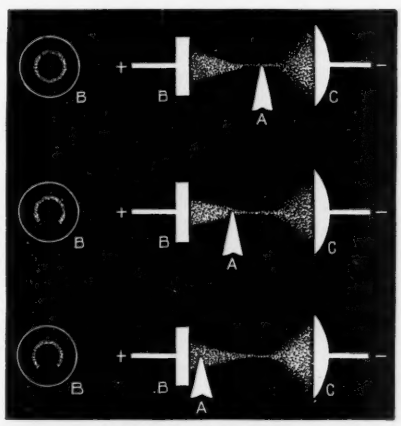
as if the conical sheet of rays were a soap film, and contracted by surface tension; B, $B^1$, $B^{11}$, shows the fragment of the ring with decreasing vacua. The position of this fragment of the luminous ring was directly opposite the gap in the cathode disc, which pointed to the view that the rays do cross at the centre, and also showed that there was no twist, as in magnetic focussing.

If we adopt the theory which supposes that the rays consist of a stream of electrified particles, the superficial concentration of the radiation might be explained by the mutual repulsion of similarly electrified particles; but the pseudo surface tension phenomenon appears to point rather to a mutual attraction, and therefore appears to go dead against the electrified particle theory.

To further confirm and elucidate these interesting results, Mr. Swinton arranged a variation of this experiment. Instead of cutting a sector out of his cathode disc, he placed a wedge, A, figs. 11, 12, and 13, in different parts of the cathode beam. When placed, as in fig. 11, at the focal point, the ring on B was complete; when placed in the diverging cone as in figs. 12 and 13 a fraction of the ring was cut out by the shadow of the aluminium wedge, A; this fraction being the same whatever the distance of the wedge from the anti-cathode. This is evidently a case of a shadow cast by rays moving in straight lines.

The results were somewhat different when the aluminium obstacle was moved into the converging cone of cathode rays. These results are exhibited in figs. 14, 15, and 16. It will be observed that the closer the aluminium wedge is moved to the cathode disc, C, the greater is the fraction of the luminescent ring which is cut off. The fragment of ring, in fact, exhibits the same contractile property as when produced by the notched cathode.

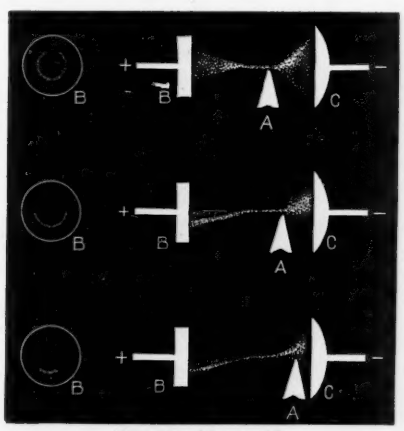
This curious contractile property of the converging cone is difficult to explain, but we imagine it has something to do with the surface charge which has been shown by Porter and others to accumulate on the outer surface of the tube in the region around the cathode. The diverging cone being beyond the influence of this charge would not be sensibly affected by it. It would be easy to ascertain if this is true by removing the surface charge by means of the wooden tube invented by Dr. Berliner* and recently described in our




Figs. 11, 12 and 13.

columns. Assuming that the cathode rays consist of electrified particles, the attraction of this surface charge may also account for the concentration of the radiant energy on the surface of the cone.

When the rays were projected from a flat cathode disc, and focussed by a convergent magnetic field produced, after Birkeland and Swinton, by a bar magnet, or after Fleming,




Figs. 14, 15 and 16.

by a circular solenoid, practically the same phenomena were observed. Hollow cones were produced giving luminescent rings sometimes with and sometimes without central bright spots on the carbon anti-cathode. Some curious phenomena analogous to those discovered by Birkeland† were observed when the vacuum of the tube was gradually lowered under the magnetic influence. The small bright spot which first appears becomes gradually larger and fainter, then suddenly becomes hollow and brighter. As the vacuum falls still

* Electrical Review, March 5th, 1897, p. 327.
† Electrical Review, June 12th, 1896.

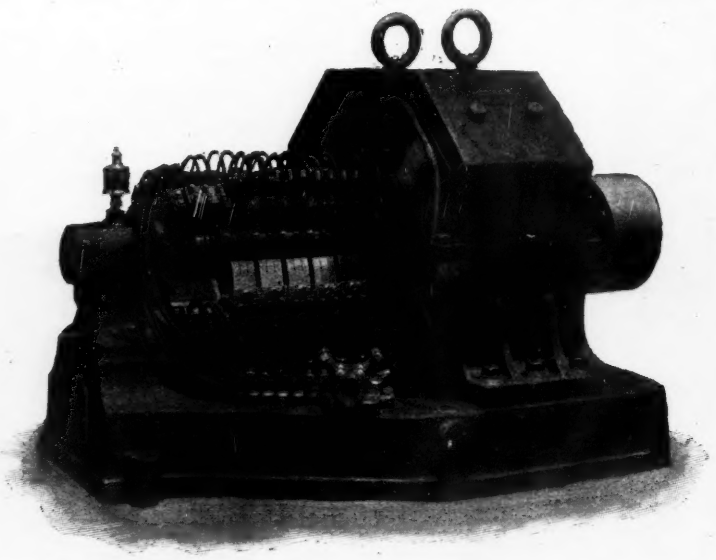
further, the ring becomes solid again, though larger and fainter than before, and finally disappears. After this stage it can be reproduced momentarily without alteration to the vacuum by switching the magnet on and off suddenly. When produced in this way it is usually hollow, but sometimes solid.

Mr. Swinton tried the effect of a concave cathode disc made of carbon instead of aluminium. When the vacuum was pretty high, the cone of rays was contracted at the base, and produced a luminescent spot on the cathode. Particles of carbon appeared to be projected from the carbon cathode, which made the cathode rays visible at much higher vacua than they would be visible in the ordinary focus tube. When two carbon cathodes were placed opposite each other, these carbon particles appeared to collide in the centre, and produce faint Röntgen rays. The conclusion that Mr. Swinton comes to is that Röntgen rays are produced only when cathode rays collide with solid substances, a generalisation which seems to be somewhat hasty, in view of the fact that cathode rays have been shown to possess the photographic and most of the other positive qualities of the Röntgen rays.

Mr. Swinton's results are an interesting contribution to the study of the new radiation, and will no doubt greatly help to the elucidation of the unsolved problems in this subject. We are pleased to note that Mr. Swinton, with commendable fairness, gives their due to other workers in this field, even though the race for priority was only lost by a neck.

## FOUR-POLE PLATING DYNAMO.

A 10½ kilowatt plating dynamo has just been supplied to the Birmingham Small Arms Company, Limited, by Messrs. W. Canning & Co., of Birmingham. The dynamo is of the multipolar type, as shown in the accompanying illustration, and designed to give an output of 1,500 amperes at 7 volts, at a speed of 890 revolutions per minute. The armature is a Gramme ring wound with stranded cable of several turns connected in parallel. The commutator has 28 sections, and there are four sets of brushes spaced at an angular distance apart of 90°, each set consisting of five Brush holders, there being two brushes in each. The resistance of the armature at 50° C. is ·000181$^{\omega}$. There are four wrought-iron field magnets equally spaced in and bolted to a cast-iron yoke frame. The four magnet coils are connected in parallel, each coil having a resistance at 50° C. of ·317$^{\omega}$.



The rise in temperature of the armature after six hours at full load is 30° C., and of the field magnet coils 32° C., the electrical efficiency at full load being 90·7 per cent.

## ACCIDENTS.

It is a common thing to set down as accidental scores of mishaps which arise simply because no proper means have ever been adopted to prevent them. On this subject our American contemporary, the *Electrical Engineer*, very properly condemns the use of the term accidental as applied to many so-named casualties. Thus the destruction of the Mount Vernon Street power house in Philadelphia is ascribed to an accident. What are the facts? Simply that the chain of a travelling crane fouled one of the dynamos. Now, while such an occurrence might be expected to wreck the dynamo, why should it burn down the station? The safety devices ought to have been equal to the abnormal load in case of the possible short circuit. Argue that it was not due to their failure but to the throwing about of molten metal on a wooden oil-soaked floor, and our contemporary asks why oil-soaked, and why the wooden floor? In a properly kept station no floor, wooden or otherwise, should become oil soaked, and no floor should be of wood. Similarly, why should the notoriously inefficient pipe joints of the gas companies be allowed to let out gas to be exploded by electricity or cigar ends, and the results attributed to electricity, as though a gas company had every right to let out their poisonous stuff upon the public as they pleased. In nine cases out of ten accident is a term used to cover wilful and gross carelessness or bad design, and the *Electrical Engineer* very properly condemns the practice of laying every mishap at the door of the poor electrician. There are apparently unforeseen, and therefore unprovided for occurrences, that may perhaps warrant the term accident, but a greasy wooden floor is not accidentally set fire to. It is set fire to when this does occur, because someone responsible has not cared to think out how dangerous such a floor may become, and has not cared, when designing it, to picture the floors he has seen of this dangerous quality, and taken steps to provide against such an "accident."

The engineering world is full of such accidents. Take single acting engines, for example, and think out the number of promising engines that have gone to wreck from failure of crank shafts. Every engineer who has had practical experience of crank shafts knows that a single acting engine requires a crank shaft to be statically about seven times as strong as that of an ordinary double acting engine of equal power. Few makers realised this condition, and these engines failed simply because they were killed by their crank shaft failures. Failures of crank shafts are glossed over as due to some external cause in place of being recognised as pointers to faulty design. Fairbairn, Hodgkinson, Wöhler, and others have pointed the moral many times during the past forty years, but many single acting engine men do not yet adorn their tales with any intellectual appreciation of the facts so plainly taught.

We remember a certain civil engineer who was wont to cry out upon the extravagant use of material by mechanical engineers because he could not understand apparent factors of safety upon static strength coefficients. His stresses were largely static and he had no grasp of moving forces. It is from such lack of perception and a certain want of foresight that so many accidents arise.

## INTERIOR CONDUITS.*

By WILLIAM A. ANTHONY.

The recent discussions in relation to the use or non-use of an insulating lining in the iron pipes used for conduits for electric wires, leads me to present for the consideration of the readers of the *Electrical World* my own views upon the subject.

* New York *Electrical World*.

The main claim by those who favour plain iron pipe is, that whatever advantage may be derived from the insulating lining of the pipe, may be as well derived from an extra thickness of covering on the wire.

At the recent meeting of the insurance inspectors in this city, a resolution was offered by the representatives of the New York Board looking to the approval of the use in plain iron pipe of a wire having a covering equivalent in all respects to the usual insulating covering approved for wires used in lined conduits, *plus* the lining of the tube. Now this is all very well if such a covering could be made, but it seems to me that the adoption of such a resolution would be equivalent to adopting a resolution to the effect that we will approve for use in place of the steel frame and hollow brick partitions of a fireproof building, wood beams and partitions having the same strength, incombustibility and resistance to heat.

The high insulation of the high-grade rubber-covered wires used for interior wiring is due entirely to the rubber covering; the layers of braid over the rubber add not one iota to the insulation resistance, but only afford mechanical protection to the rubber covering. For wires that are to be drawn into conduits, thick, heavy coverings of braid are very objectionable, since they greatly diminish the flexibility of the wire, and increase the difficulty of drawing it around angles or bends in the conduit, and so increase rather than diminish the danger of the covering being torn and the insulation impaired in the process of drawing in the conductor. Some experiments that I have undertaken, but have not yet completed, tend to show that the insulation of a heavily covered conductor, like the "Attix" wire, is much more quickly impaired by bending than is that of the ordinary standard insulated wire.

If plain iron pipes are to be used at all for conduits, there is no better insulated conductor to draw into them than the standard wires and cables now used for the insulated conduits. The idea that additional coverings of braid will lessen the chances of injury while the wire is being drawn in, or will serve to lessen the probabilities of deterioration afterward, is an error.

The danger of injury during the drawing of the wire into plain iron pipes is mainly due to the roughness of the interior, to the fins and splinters that always exist on the inside of pipes, and to the burrs and sharp corners left in cutting. The interior roughness is entirely covered by the insulating lining in the lined pipes, and the burrs turned in by cutting do not reach through the lining. The lining itself is a far better insulator than the extra braids on the outside of the insulated cable can possibly be, considering that the cable is being continually bent and twisted in the handling, until it is finally in place in the conduit. As a mechanical protection to the wire while it is being drawn into the conduit, the lining in the pipe is infinitely better than any extra covering on the outside of the wire—that must be bent and twisted and subjected to all the strains incident to the handling of the wire—can possibly be.

But there is still another danger. In spite of all precautions moisture will get into the conduits. Against this moisture the extra covering on the wire is absolutely no protection. All that the wire is with it, it would be without it. But the inside of the unlined iron pipe will rust, and this rusting is a menace to the insulation on the wire. The lining in the iron pipe, adhering as it does closely to the inner surface, will protect the pipe from rusting, and so tend to preserve both pipe and wire.

If plain iron pipe is to be used at all for conduits it must in some way be rendered absolutely smooth and free from fins and splinters inside. All burrs caused by cutting must be conscientiously removed, and all sharp corners carefully rounded. Then, for the conductor to be drawn into it, I repeat there is nothing better, nothing else so good, as the standard high grade wires and cables now used. But no one would claim that such an installation would possess the same advantages as an installation consisting of the same wire drawn into a pipe having an insulating lining, and it seems to me the height of absurdity to suppose that the advantages of the insulating lining can be obtained by putting an extra covering on a wire that already possesses little enough flexibility.

## REVIEWS.

*Les Accumulateurs Electriques.** By F. Loppe, Ingénieur des Arts et Manufactures. Paris: Gauthier-Villars et Fils, and Masson et Cie, Boulevard Saint-Germain.

The first part of the work, comprising 13 pp., is devoted to the principles of electro-chemistry, including the laws of Faraday, of Thomson, and of Becquerel. In the following passage we notice that the term "potential" is not used in accordance with its scientific definition:—"The electrode at the higher potential, that by which the current penetrates, is designated by the name of *anode* or positive electrode." This, of course, would negative the statement that the negative electrode may be at a high potential, whilst the positive electrode may be at zero potential, *i.e.*, in contact with earth. We note also that the following statement is obscure, viz., that "In accumulators (as distinguished from primary batteries) the anode is ordinarily termed the positive plate and the cathode the negative plate." This is the case with primary batteries; the peculiarity of the terminology in the case of secondary batteries is that the anode *in charging*, which is the cathode in discharge, is termed the positive plate. At the end of this portion of the work is a table of the specific resistances of more or less dilute solutions of sulphuric acid.

Part II., extending over 16 pages, treats of the definition, classification, and methods of utilising accumulators. We notice that the credit of first suggesting the use of accumulators as tension (or pressure) regulators or "regulating voltmeters" is ascribed to M. Reynier. Two systems of distribution from accumulators, located at sub-stations and charged in series from a central station, are distinguished, viz., that of M. Monnier, in which the sub-stations are supplied with only one battery, which is for most of the time under charge; and that of Mr. King, in which each station is furnished with two batteries, one under charge whilst the other is in use for lighting. Five pages are devoted to the use of accumulators in central stations, both as reservoirs of energy and as pressure regulators.

Part III., extending over 114 pp., is the most important, and is exclusively devoted to the theory of lead accumulators and to the modifications of the apparatus employed in practice.

"M. Tscheltzow," says the author, "was the first to give a thermo-dynamical verification of the double sulphation theory, by measuring the heat of formation of binoxide of lead ($Pb O_2$). This and other thermal values involved in the battery reactions are given as follows, the gramme equivalent of the various bodies being adhered to (in lieu of the gramme-atom to which Thomsen's values, as usually given, refer), and the heat being given in kilo-calories or "large" calories.

| | | | |
|---|---|---|---|
| Oxide of lead (Pb O = 111·5 grammes) | ... | 25·5 calories. | |
| Binoxide of lead ($Pb O_2$ = 119·5 grammes) | ... | 31·6 | „ |
| Sulphate of lead (from Pb and $S O_4$) | ... | 36·2 | „ |
| Do. do. (from Pb O) 36·2 − 25·5 | = | 10·7 | „ |
| Do. do. (from $Pb O_2$) 36·2 − 31·6 | | 4·6 | „ |

Thus the calories disengaged according to the double sulphation theory would be:

| | | | |
|---|---|---|---|
| From the sulphation of the equiv. of spongy lead | | 36·2 calories. | |
| „ „ „ peroxide | | 4·6 | „ |
| Total | ... ... | 40·8 | |

Thus, from the formula

$$E = \frac{H}{23} \text{ volts},$$

in which H is the quantity of heat, in kilo-calories, generated by the passage of the gramme-equivalent of electricity, viz., 96,600 coulombs or 26·7 ampere-hours, the electromotive force of the lead couple would be

$$E = \frac{40{\cdot}8}{23} = 1{\cdot}77 \text{ volts}.$$

"The mean electromotive force," says M. F. Loppé, "is 1·94 volt; the difference being accounted for by the temperature correction of Helmholtz (in the expression $E^1 = E + T\frac{de}{dT}$), which in this case is positive, since heat is absorbed in the battery during discharge."

* The present work forms part of the "Encyclopédie Scientifique des Aide-Mémoire," published under the direction of M. Léauté, Membre de l'Institut.

This supposed agreement between observed results and theory is certainly open to criticism, and, in our opinion, must be taken with several grains of salt. In the first place, the figures given as the thermal equivalent of Pb | $SO_4$ are purely theoretical, and the compound $SO_4$, which has never been obtained, has certainly a thermal value differing from that of $SO_3 + O$. Recent writers on the thermal chemistry of the lead accumulator have adopted very different values for the heat produced—or that would be produced—by the combination of the gramme equivalent of Pb with the radical $SO_4$. Thus, if we remember rightly, Mr. E. J. Wade adopts the figures 56·5 kilo calories, or thereabout, Mr. Maurice Barnett 72·7, and D. G. Fitz-Gerald 46·0, and 37·9 as the maximum and minimum values. And, in the second place, the mean E.M.F. that would be exhibited by Pb and Pb $O_2$ if these two bodies could be entirely converted into 2 Pb $SO_4$ in presence of sulphuric acid would be very much lower than 1·94, or even than 1·77 volts. Indeed it is only prior to the conversion of Pb $O_2$ (or, rather, of its hydrate), into a body [Pb $O_2$ 2 (Pb $SO_4$)] presenting some analogy with the ordinary variety of minium or red lead, viz., Pb $O_2$ 2 Pb O, that potential differences approaching the above can be observed. The fact is that, although the equation expressing the double-sulphation theory expresses, in a sense, what really occurs, it is impossible to accept it *au pied de la lettre*, since, in the words of M. Drzewiecki, "a positive plate in the condition of sulphate could never pass (by charging) into the condition of peroxide."

*(To be continued.)*

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*Le Carbite, Nouveaux Procédés pour sa Fabrication.* Raoul Pictet. Geneva, 1896, W. Kündig et fils.

*L'Acétylène, son Passé, son Présent, son Avenir.* Raoul Pictet. Geneva, Georg & Co., 1896.

*L'Eclairage à l'Acétylène.* G. Pelissier. Paris, Georges Carré and C. Naud, 3, Rue Racine, 1897.

French scientists have always been exceedingly prompt to place their results before the public, in spite of that curious system of sealed papers which is countenanced by the Academy of Paris. Search where we may, in whatever department of science, and we shall always find that our French contemporaries have been amongst the first to set about creating a literature for a new subject. We are not surprised, therefore, to find that the most informing books as yet published concerning the use of acetylene as an illuminating agent, are in the French language.

Of course, Monsieur Pictet, who has identified himself so much with the commercial application of this gas might have been expected to have contributed his views in book form, and the two brochures which have appeared under his name, entitled respectively "Le Carbite" and "L'Acetylene," show very clearly the difficulties which have up to the present time been surmounted. In the first of these, "Le Carbite," the author discusses the chemistry of that remarkable product of the electrical furnace which is known by that name. He then goes on to consider the energy necessary in order to produce carbide of calcium, and the plant which he employs. Naturally he compares his own system of producing carbide of calcium very favourably with other systems, and shows, at least to his own satisfaction, that this product can be more economically manufactured according to his process than by any other. The figures given concerning the prime cost are a little hazy, and are evidently based more upon laboratory experiments than upon actual practice, but if we are to accept them, we must admit that the author can produce in his new furnaces, carbide of calcium, absolutely pure, of the finest quality, at the low cost of 82 francs per ton. So far, so good, and the author is on safe ground when he deals with this new product of the electrical furnace. When, however, he turns to the subject of lighting by means of acetylene, the subject which is discussed in the brochure entitled "L'Acetylene," it is noticeable that Pictet adopts the manner of a counsel pleading a cause. He endeavours to convince by arguments which are for the most part based upon his own convictions, and when we read the final sentences, and are informed that acetylene is destined to illuminate the whole world, we get the key to the *raison d'etre* of this book. Nobody on this side of the channel believes that acetylene is going to do all this, and we should be very much surprised to hear that Monsieur Pictet had succeeded in convincing himself of it also. Apart from all this, the book is interesting, inasmuch as it states very clearly what carbide of calcium is, how acetylene is produced, purified, liquefied, and utilised. There is an interesting chapter too on the theory of the flame obtained by burning acetylene, whilst a number of economic questions are discussed towards the end, but discussed, as we have intimated before, in the manner of an enthusiastic advocate rather than in the judicial manner.

When we come to Pelissier's book we have a general boiling down of most that is at present known concerning the history and the manufacture of acetylene, the apparatus in which it is used, the applications for which it is best suited, and its dangers. The book bears the stamp of careful workmanship and is well illustrated. Altogether it is a much more scientific production than the brochures of Pictet. The author has no particular cause to plead, and, consequently, he is able to maintain a judicial attitude throughout his work. He does not hesitate to admit the toxicity of this new gas, and the dangers which surround its use. Neither does he hesitate to inform us that there are many other methods of producing acetylene besides that which has been given to the world with such a flourish of trumpets by Raoul Pictet. He recognises that for the present there are many practical difficulties in the way of using acetylene, and although he anticipates that in time we shall be able to use it with safety and advantage in many directions, he does not claim that by means of it we have reached the *ultima thule* of illumination. Altogether, we commend Pelissier's book to those who are interested in acetylene, as providing them with a calm *resumé* of all that is actually known concerning it, and as giving them a moderate outlook regarding its future.

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*Advanced Mechanics.* Vol. II. Statics. The Organised Science Series. By W. Briggs, M.A., and G. H. Bryan, Sc.D. London: W. B. Clive, University Correspondence College Press, 13, Booksellers' Row, Strand.

Well arranged and well got up, there is really little, if anything, that can be criticised in this book. On page 5, a modification of Newton's proof of the parallelogram of force is given, which may be commended. Whether the multiplication of books of this kind is an advantage to educational progress may be doubted; it becomes distinctly embarrassing when one is asked to recommend a book for a student, although in the case before us we can readily do so.

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*Practical Electricity.* By W. E. Ayrton, F.R.S. Completely re-written. Vol. I.: Current, Pressure, Resistance, Energy, Power, and Cells. London: Cassell & Co.

In 1887 the first edition of this book appeared, since which time it has most deservedly earned a world wide reputation. Although the work has been entirely re-written, and may, therefore, almost be regarded as a new book, it retains all the excellent features of the original issue as regards style and arrangement.

The old fashioned illustrations with which so many modern scientific works are garnished have no place in "Practical Electricity," nor are old fashioned and cramped descriptions given; everything is eminently practical, and theory is rubbed in, not in the frigidly formal style as of old, but by plenty of practical examples, which in the old days would have been held to have indicated that the writer was distinctly weak in mathematical knowledge, but which no one would venture to assert was the case with Prof. Ayrton. The Professor is one of the very few who seem to have grasped the fact that what is perfectly clear to themselves, is not necessarily equally clear to others, hence the excellent style of the book.

The present Vol. I. is intended to assist students in acquiring experimentally an exact working knowledge of current, difference of potentials, resistance, energy and power; the important question of "working cost" being gone into; in view of the periodic booms in primary batteries, this is a most valuable feature, and may materially help towards

checking the preposterous claims which are so often made on behalf of these sources of energy by both the ignorant and the unscrupulous.

The author points out, what is often not noticed, that any method of trying to prove Ohm's law experimentally by means of a *current*-voltmeter is most misleading. If a voltmeter is used for the purpose, it should be of the *electrostatic* type, and dependent for its indications upon the potential difference it is required to measure only, and not upon an independent electrification also. The author describes such an instrument, designed by Mr. Mather, which appears to be well adapted for the purpose of measuring small potential differences.

About 30 pages at the end of the book are devoted to "A Short History of the Absolute Unit of Resistance, and of the Electrical Standards of the Board of Trade."

We look forward with great pleasure to the publication of Vol. II., and have little doubt but that it will be as deserving of admiration as Vol. I.

## INDIA-RUBBER PLANTATIONS.

Within the last few years there has been drawn so much public attention to India-rubber on account principally of the enormous development of the cycle trade and to no small extent by the proved excellence of this material for use as an insulator in electric installations, that people wishful to profit by the present low price of money have formed and keep forming rubber exploration companies.

In the interest of lowering the price of a raw material which has become a necessity in the electrical world we have nothing to say against these schemes. If we cannot absorb all the money ready for investment in our own industries, by all means let us welcome any action of financial combinations which may provide us with cheaper products to be employed in these industries, and from that point of view we are glad to see come forward hardy pioneers who will undertake enterprises which, whatever may result to the pioneers themselves, must be to our benefit. There are doubtless in the world—notably, in tropical America and in tropical Africa—large areas to-day unexplored thoroughly, that are admirably adapted for rubber-growing, and clever management and plenty of cheap labour can bring about results which will lower the price of this desirable gum. For the ultimate success of the business, the promoters of these exploration companies will be wise in their day and generation, however, if they are careful not to over-capitalise their schemes, and if they prudently provide large working capitals. This should be easy, as the first cost of a rubber estate, which is generally virgin forest land, must be very small indeed. In many cases, and in the best districts, a Government grant of land should be easily obtained for little more than the registration fees, by submitting to the usual export duty. If the company should desire to compound with the Government and sit duty free for a period of years, no doubt the price to be paid for this composition would be a high one, as the export duties are generally very heavy. When the estate-purchasing questions are settled, the difficulties are far from being removed; the arrangement of collecting centres, the gathering round these centres of a sufficiency of cheap labour, the provisioning of the labourers, the transport to and from these centres of the rubber in one direction, and the provisioning, clothes and tools, in the other, will require very serious consideration and great organising talent in the management. To carry out successfully this last part of the programme, and to provide the management with the sinews of war, a large working capital is required; unfortunately, it is generally in this last respect that such schemes fail.

Promoters of these schemes have to-day at their disposal experts who can give them sound advice as to the class of India-rubber which will best repay their attention. The classes of rubber in existence are so varied in their quality and price, that expert opinion is highly necessary as a guide to intending investors. We cannot criticise in detail any of the schemes that come before the public from time to time, as a correct opinion can only be formed by local knowledge, which we regret to say we are totally unable to furnish. We have tried, however, to lay before our readers what we consider, in a general way, to be the precautions which should be taken in such a speculative business as rubber gathering and planting.

## SUBTERRANEAN AND SUBMARINE RIVERS.

A contemporary seems to infer that the time of the Institution of Electrical Engineers was wasted by the reading and discussing of Mr. Benest's paper on recent submarine cable repairs. The critic advances the observation that the meeting was thinly attended, and deduces from this that the matter was uninteresting to the body of members. He apparently forgets that the 150 members or so who usually attend these meetings are mostly London men who have no interest in the world's nerves, and form a fraction of the whole number composing the membership. The members who are interested in applied electricity generally, but more particularly in the submarine branch, are stationed in all parts of the world, and are seldom able to attend the Institution meetings. When Mr. Benest's paper and discussion reach the members in the Institution's printed proceedings they will be very widely read, and we doubt not with considerable interest by a large majority of members, and we think the Council are very wise in catering occasionally for those members who may not reside in London or its neighbourhood.

Considering the open-handed and un-Kruger-like policy that prompted the telegraph branch of electrical engineers to receive in their midst the large-current Uitlanders, and the weary hours some of them passed in listening to the hasty ill-considered opinions of the fledglings while hoping for better things to come, a hope fully justified, it seems a little ungracious to carp and help destroy the concert now existing between the different branches of the profession.

With this slight reproof to a junior contemporary, we will pass on and mention a record sent to us by a correspondent which may aid the discussion of Mr. Benest's paper. The record states that the Rivers Alpheus and Eurotas, after running together for 20 stadia (about 3·5 miles) in the Peleponnesus, traversed a subterranean passage, and emerged respectively in the territory of Megalopolis and in Laconica. Virgil says it was fabled that Alpheus passed under the sea to Sicily and burst out as a fountain near Syracuse, out of love for the nymph Arethusa. Although Alpheus did not woo his lady love with Persian carpets and golden orange skins, such as Mr. Benest mentions in his paper, yet the legend, existing 1,900 years ago, of the flowing of water from Greece to Sicily seems worthy of bringing to light, as also the fact that since the earthquake of 1170 A.D. the waters of the fountain of Arethusa are mingled with sea water.

## THE RIBBE ACCUMULATOR.

On Tuesday morning last, we, with other technical journalists, newspaper representatives and gentlemen commercially and practically interested in electric tramcar propulsion, journeyed to the wilds of Deptford, where we had been invited to witness the trial of a tramcar fitted with the secondary batteries of Herr Paul Ribbe. For reasons which are needless to mention, the car was not allowed to run in the streets, and therefore did not leave the depôt of the London, Deptford, and Greenwich Tramway Company, so the benighted wayfarers who, after much inquiry and tedious journeying had arrived upon the scene of action, were obliged to content themselves with gaping at the car and scrutinising a battery plate.

Briefly, the Ribbe plate is made of thin perforated lead sheet pasted with active material, and enclosed in perforated celluloid covers. There are minor details of construction in placing a number of these together to form a cell; but, for the life of us, we cannot see any visible improvement over batteries already known which have been tried in this country and found wanting.

A descriptive circular told us of the three conditions which an accumulator must fulfil, and then followed some curious figures.

"A tramway battery constructed on this system, consists of 140 cells having a capacity of 81,000 watt-hours, and a total weight of 2,800 kgm. Each five cells are enclosed in a box which is air-tight except that it is connected by a short India-rubber tube to a common tube to allow the gases produced during charging to escape."

"This output corresponds, according to results obtained elsewhere, to more than a 20 hours' run, and it will depend on further practical experiments how much the weight can be reduced in a battery which is sufficient for the ordinary 16 hours' run."

Now, 81,000 watt hours represent 81 units, and a 20 hours' run, and more, can scarcely be estimated as covering less than 120 miles.

We should like to see this car with an ordinary complement of passengers, and nearly 3 tons of dead accumulator weight, careering along with the expenditure of less than $\frac{3}{4}$ of a unit per car mile on the usual type of tramway track.

As to the durability of the Ribbe plates, we have no more faith in these than in others which have gone before to destruction, and we are strongly of opinion that, quoting the circular, "further practical experiments" should have been made by subjecting it to a long continued course of actual work on tramcars, before attempting to introduce the invention in this country.

Batteries tested in a laboratory may be subjected to the same variations of load as occur in tramway operations, and were this the only point to be considered, they would have become commercially successful long ago; but let the Ribbe cells be subjected to the incessant vibration, shock, and disintegrating action of daily work in a car, and we would not stake much on the life of such a plate, which is much too fragile looking. Nor would we pin our faith to the infallibility of celluloid, judging from our own experiments on this material when used as an envelope for battery plates, and from the experience gained by experienced manufacturers and users.

A complete cell weighing 7·2 kgm. is said to have a capacity of 92 ampere-hours, but as the rate of discharge is not given, this statement might just as well have been omitted for any value that can be attached to it. Moreover, we could readily point to several types of accumulators already in the market which possess all the advantages, and more, that are claimed for the Ribbe.

## THE AMPLIPHONE.

This instrument, which is now attracting wide attention among the medical profession on account of its peculiar adaptability to their uses in the magnifying of sounds pertaining to diseased organs, &c., is the invention of A. A. Knudson, well known as an inventor in electrical and acoustic apparatus. Although, says the New York *Electrical Engineer*, this invention was patented ten years ago, and first

intended for use in telegraphy, by providing a method by which only the operator could take a message from a relay adjusted low, it has not as yet come into use for that purpose, although successfully tried on the lines of one of the large companies. The instrument itself as now designed is very simple in construction. By referring to the cut a good idea of its construction and appearance may be obtained. It will be seen that the magnified sound of the ampliphone is conducted to the ears of the person using it, through rubber tubes which terminate in hard rubber ear bulbs similar to those of the phonograph. These rubber tubes branch out from the Y-piece of the instrument, A, which is inserted in the socket which connects with the air chamber of the instrument. B is the hard rubber knob which is screwed to a stud which projects through the diaphragm, C, which serves as a handle to manipulate the instrument. C is the upper diaphragm, the lower one not being shown, but is an exact counterpart; both of these diaphragms are pressed out of very thin aluminium, the exact thickness being 12/1000 of an inch, and are shaped with circular corrugations. These diaphragms are slipped over the edges of a brass rim having grooves into which the edges of the diaphragms are depressed and are thereby firmly secured. A polished rubber ring is then driven over the whole which completes its finished appearance. D is a metal bell-shaped terminal, which is placed against the object or person whence the sound emanates. E is a hard rubber bell screwed to the end of the small metal tube, which is also screwed when in use into the metal bell, D, attached to the instrument.

The whole appliance weighs but two and a half ounces and can easily be carried in the pocket. A morocco case lined with satin is furnished in which it is kept together with the tubes when not in use. Mr. Knudson informs us that he expects to make other applications of this invention either in its present or modified form, and we shall look with interest for new developments in other fields where it may prove as useful and successful as it is now in the medical.

## AN ELECTRIC SYSTEM OF WORKING SIGNALS AND POINTS.

Anyone who has read Mr. Hollins's recent paper to the Institution of Electrical Engineers will be ready to admit that the working of railway signals and points has been brought to a greater state of perfection in this country than anywhere else; but the system of transmitting power by rods or wires and bell cranks strikes many people as being somewhat behind the times, and gives rise to a suspicion that the conservatism of our railway engineers may be retarding an improvement which would lead to a greater economy, if not a greater reliability in working. The transmission of power by the mechanical movement of connecting pieces is rapidly being displaced by electrical transmission even for comparatively short distances, as in the driving of machinery in factories and workshops. Unless there are some exceptional circumstances in the working of points and signals, the same principle might be thought to apply. Messrs. Siemens and Halske have had the courage and foresight to apply electric transmission to railway point and signal working in Germany, and apparently, with complete success, but we must await the lapse of time to be assured that it is so.

In the Siemens-Halske system, every switch and every signal is fitted with a special continuous current motor, which brings about the reversal of the points, or the signal, in question. The motor is supplied with current from a battery of accumulators, to which it is connected by three wires, one for each direction of rotation, and one as a return conductor. The motor is connected alternately to one or the other of the two forward leads by a reversing arrangement automatically controlled by the signal or the points.

In the arrangement for moving the points, the motor and the setting and locking roller are enclosed in a cast-iron housing. The roller is actuated by a cam, the movement being communicated to both switches by rods. When the points have been reversed and locked, the working current is interrupted, and a controlling current switched on, which, by means of an electro-magnet in the signal box, informs the signalman that the reversal of the points has been completed. Incomplete reversal of the points, or a breakdown, is indicated by the non-appearance of the controlling current. When the motor has switched on the controlling current, the

signalman can set the points for another line by moving a reverser in the signal cabin. The reverser, however, can only be moved when there is no vehicle on an insulated section of the rails extending some distance in front of the points.

The arrangement for setting the signal is exactly similar. The setting roller takes with it a lever, intended to actuate each signal arm, but none of these arms will have the movement of the levers imparted to them, except the points are correctly set for the line in question. This result is attained by inserting an electro-magnetic coupling between the setting roller and the signal arm. This coupling is switched into a circuit, which passes through a contact on the control magnets of the points belonging to the signal in question. If anyone of these contacts is not closed, owing to its particular set of points not being in correct position, no current passes through the electro-magnet, and the signal arm, by the action of its counterweight, goes to danger. The coupling current may also be led through cut-outs in the station buildings, or in adjacent signal boxes, from which permission may be required to lower the signal. By this means the setting of the signal can be controlled, the setting of the signal can be delayed, or a signal set to "line clear" can be immediately put to "danger." The latter result is also attained by pulling a lever in the signal box. For multiple arm signals only one such lever is required.

The mechanical connection between the points and the signals is made in the usual way. There is an essential improvement with this system that the pulling of the line lever first rectifies wrongly set points, and then locks them.

The consumption of electrical energy in one electromotor for a signal or points, on the assumption of an average of 200 reversals per day, amounts to 190 watt-hours per day, or corresponds to the amount of energy required to supply a 16-candle glow lamp for 3½ hours.

The principal advantages of such a system of signalling may be stated as follows:—The abolition of kinematic transmission and the substitution of cable conductors, the maintenance of which is far simpler and cheaper; the working of the signal levers without so much bodily exertion; the increased security on account of the permanent connection of the signals and points, and more highly developed control arrangements.

The cost of such an installation is not essentially higher than an installation with rods and wires. Several of these installations have already been at work for some time, and have worked very satisfactorily; a number of new installations are at present being fitted up, one of which, at Stuttgart includes 130 points and 29 signals.

## MOTOR CAR DISCUSSION AT THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Whether the recent developments (or opportunities for development) in motor car traction in this country have had a sort of reflective effect on our American cousins, or whether it may simply be due to a growing need across the Atlantic for these by no means perfect contrivances, we do not attempt to say; but the fact is worth chronicling, that the American Institute of Electrical Engineers has given up an entire sitting to a discussion upon electrically propelled street vehicles or motor cars, and some of the speeches deserve a little notice, especially as it proved impossible altogether to keep out all mention of oil and gas motors.

Of course, the chief consideration in such a matter from the electrical engineer's point of view is the particular type of accumulator to be employed, and the opinions expressed by the speakers appear to be very "various." The first had found the best results obtainable were represented by about 5½ watt-hours per pound of battery, running for 4 to 5 hours at 10 miles an hour on a single charge. Others limited the run to 25—35 miles in all, on a single charge, one battery to give an output equal to the smaller distance, weighing 800—900 lbs. The car in such a case weighs, all told, about 2,500 lbs., and runs at 9 to 11 miles an hour, using about 25 amperes. Dr. Duncan seemed to doubt the existence of an accumulator that would serve for a run of as much as 35 miles in ordinary working, being supported in this by the next speaker, who thought 25 miles might be run on good roads while with poor traction probably not more than 10 could be done.

Further discussion appears to have leaned away from the storage element to the mechanical questions affecting the motor drive—whether one motor driving both wheels or two separate motors one for each driving wheel—also the use of two speed gear in hill climbing, steering gear, the mounting of motor, &c., on a separate driving truck, attached more or less flexibly to the main car body, and therefore obviating some amount of jar, &c., and finally the general construction of the car as a vehicle.

The advocates of gas and oil motors were not wanting; and their existence is quite justified from a financial standpoint, seeing that there is not, as yet, a plu-perfect storage battery giving a horse-power hour per pound weight, and not much prospect of same in this world. For all that, however, a brief comparison in actual running between the two types of vehicle—gas and electric—such as might be obtained at the recent "Motor Car Day," is quite enough to convince one that if the storage battery is not yet perfect, it does not, at any rate, involve the use of an appliance that "barks like a dog and smells like a cat," to quote the elegant language of a spectator with regard to gas and oil motors.

## CORRESPONDENCE.

### Insulated Conduit.

If Mr. Bathurst could not understand my letter because he found the metaphor involved, he should not have added to his difficulties by quoting without reference to the context. When I spoke of comparing workmanship, I naturally referred to the installation of the conduits, and I take it that the insulated conduit lends itself to scamping as well as any other system. When I referred to the encouragement to put in bad wire, my meaning was quite clear; wire is *material* not workmanship. Therefore the two statements have no connection, and certainly, if workmanship is eliminated as is only fair, we are left with quality and cost of material.

Knowing from experience how impossible it is to keep out moisture in a pipe system, and consequently leakage at outlet points, I do not see how the I.R. can be allowed to depend on the insulation of the conduit. Moreover, the more equable temperature of the bitumenised paper (and this *is* organic) will not tend to evaporate the moisture; and therefore, although we may have no alternations of dryness and moisture, the continued presence of the latter would soon wear down shoddy insulation and cause leakage, and if the circuit is not properly fused, arcing; also moisture finds its way into all these systems, quite apart from any condensation.

The only way, therefore, is to use high class insulated wire, and it does not matter what you put round it afterwards, as long as it is mechanically protected and accessible. Why, then, should we pay for the extra cost of insulating the tube? I only put this question from a disinterested point of view, as it seems to me that good wire, mechanical protection, and accessibility are all that is necessary to make an installation successful and durable.

V. Zingler.

*April 4th*, 1897.

### Trunk Telephones.

Owing to my absence abroad I have only now seen Mr. Pierart's last letter.

I think the explanation of the apparent discordance is obvious. If there were no such elements as static capacity or self-induction, the rise and fall of a current at both ends of a circuit would be instantaneous, the curve would be a straight line, the speed of working in telegraphy would be limited by mechanical conditions alone, and the distance over which a telephone could speak would be practically unlimited. On the other hand, simultaneous telegraphy and telephony on the Van Rhysselberghe system would be impossible, as the rise and fall of the telegraphic current would

cause deafening sounds in the telephone. Taking facts as they stand, however, the rise and fall follows the well known laws which define the curve assumed by an outgoing current at the distant end, the speed of telegraphic signalling depending on the form of this curve and the time that elapses before it reaches the height necessary to work the apparatus. The introduction of shunted condensers hastens the rise and fall of this curve, quickens the speed, and as a result increases the inductive effect on neighbouring wires. As an illustration, swing a portion of a suspended circuit in the earth's magnetic field. A galvanometer needle in circuit will be violently deflected; a telephone in circuit will be silent. Affect the circuit inductively by making and breaking a current in a neighbouring wire, and the telephone will give a much greater indication of the effect than the galvanometer does. In one case the curve rises and falls very gradually; in the other the reverse takes place.

Van Rhysselberghe's system, which is quite inapplicable to high speed telegraphic circuits, is so designed as to lengthen the curve to the utmost extent compatible with the reception of the telegraphic signals on the circuits adapted to this form of working. Apparently, in the instance referred to by Mr. Pierart, this lengthening has been carried somewhat too far, and a correction has had to be applied in the form of a shunted condenser.

Possibly a modification of the other elements in the construction might achieved the same result.

**J. Gavey.**

*April 1st.*

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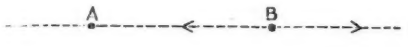
### Commutatorless Continuous Current Dynamo.

We have read in the Electrical Review of last week, Mr. X. Y's remarks concerning our letter of the 17th inst., but before replying in detail we would be much obliged if he would tell us if, in his opinion, a material point, A, can act upon a material point, B, so as to tend to make it move in any other direction than that of the straight line, A, B.




Moreover, we will tell him that in our non-polar dynamo (*which exists and works*) the whole of the magnetic mass revolves with the bars in which the electric current is induced without there being any relative speed between them.

We would request Mr. X. Y., after consideration of the points mentioned above, to read again our article of the 17th inst., and he would greatly oblige us if he then gave us again his opinion of the way in which the electro-magnetic phenomena are usually interpreted.

**A. De Puydt & M. Poncin.**

*March 31st*, 1897.

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### Country-House Lighting.

With reference to the article on "The Electric Lighting of Country Houses," read by Mr. A. H. I. Graham, before the students of the Institution of Electrical Engineers, and published by you in this week's issue, there are one or two statements which require some slight modification.

It is stated in the article that "the consumption of coal gas in gas engines is about 20 cubic feet per brake horse-power hour. As each horse-power supplies current for about 15 lamps of 16-candle-power, we have a gas consumption of about one and one-third cubic feet per hour for each 16 candle-power lamp, whereas the gas consumed direct, about 5 cubic feet per hour, must be allowed for each 16 candle-power burner."

It seems to have been overlooked that one B.H.P., being equivalent to 746 watts, that the output of a dynamo having an 85 per cent. efficiency would only be 634 watts per engine, B.H.P. Assuming that 16 candle-power lamps, taking $3\frac{1}{2}$ watts per candle-power are used, we thus have only sufficient energy to light 11·3 lamps, thus equalling a gas consumption of 1·77 feet per 16 candle-power lamp. If, as is often the case, the lamps are lighted off the battery, the battery having a watt efficiency of 80 per cent., we again reduce the available number of watts per engine horse-power to 507, which, still assuming that 56 watt lamps are used, means only, say, 9 lamps per 20 feet of gas used by the gas engine, and therefore 2·2 feet per lamp, instead of the one and one-third feet stated in the article.

In the item, "Cost of Working," we have, after the cost of the motive power being given, the following remark:—"Besides this cost we have practically only the cost of lubricating oil and sulphuric acid, so that the light would be very little more expensive than previously."

It is readily understood that lubricating oil would have to be purchased, but no sulphuric acid should be required after the cells had once been sufficiently filled, water only being added to compensate for evaporation.

Attention is only drawn to the above apparent errors as it is certainly desirable in the interests of the electric lighting industry, that every care should be exercised in giving the relative cost of electric and other methods of lighting, so as not to afford opportunities to interested parties to cast reflections upon the absolute fairness of such comparisons.

Trusting that you will be able to find room for this letter in your next issue.

**H. Davenport.**

*April 6th*, 1897.

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### Colwyn Bay Electric Lighting Scheme.

I am pleased to see that Mr. Bennett has opened a discussion in the columns of your journal on the subject of the above scheme.

Like Mr. Bennett, I travelled to Colwyn Bay in December, and took the necessary particulars for the purpose of preparing a scheme. I was much surprised, however, on seeing a list of competitors that a relative of the Town Clerk was competing.

In public competitions of this kind the impartiality of the adjudicators should be like Cæsar's wife, beyond suspicion; and it is very regrettable that the action of the Colwyn Bay District Council, and Messrs. Fawcus and Clirehugh, combined with Messrs. Booth, Chadwick and Porter, should be of such a nature as to raise questions as to their impartiality.

The town of Colwyn Bay, although not covering a large area, is by no means thickly populated, the houses and public buildings being, for the most part, some distance apart. The distance from the generating station to the extreme end of the mains in the compulsory area is about $1\frac{1}{2}$ miles, and from the station to the most densely populated part of the town, about $\frac{3}{4}$ of a mile. The probability of extensions to outlying districts, particularly to Old Colwyn, had also to be taken into consideration. Under these circumstances, I recommended a high tension alternating scheme for Colwyn Bay, and estimated for an installation in the first instance of 2,500 8-candle-power lamps to be connected at the same time, with 22 arc lamps for street lighting and promenade to be supplied by a constant current dynamo at 1,000 volts continuous. There would be also 50 32-candle-power glow lamps for street lighting.

I proposed to employ transformers in street boxes for reducing the voltage. Being informed that it was advisable to keep the cost of the installation as low as possible, I drew up the scheme accordingly. The estimated cost of plant, buildings, and contingencies came out at £6,879, with £1,000 extra if a refuse destructor should be erected. This price included two Babcock and Wilcox boilers, and a standby arc lighting dynamo and engine.

Although one of the unsuccessful competitors, I think my scheme compares favourably with any of those sent in point of low first cost, efficiency, and assurance against breakdowns.

I trust Mr. Bennett's letter will be the means of bringing about a healthy discussion on the subject of the Colwyn Bay scheme, and it is to be hoped that the discussion will have the effect of creating a fairer and more impartial spirit in connection with open competitions such as this.

**George Adams.**

Westminster, *April 6th*, 1897.

## THE TELEPHONE SERVICE.

In the House of Commons, on Friday last week,

Mr. Bartley (Islington, N.) rose to call attention to the unsatisfactory and imperfect condition of the telephone service in the metropolis. He asserted that, as compared with other places, London was badly served, the cost of telephonic connection was great, the delays in the transmission of messages serious, and the whole system not very creditable to the greatest commercial city in the world. He was aware the National Telephone Company would say that the real difficulty was to get way-leaves for the wires. There was no doubt a difficulty there, but he was not concerned with the telephone company, his contention being that by some means or other there should be an efficient, rapid, and economical telephone service in London. Whilst saying nothing against the present company, he did not see why the whole of London should be subservient to one company, believing there was ample room for two. Whether that was so or not, he submitted that the Post Office, as responsible in these matters, ought to insure a more efficient and more economical service. Far more important than cheapness was it that persons requiring telephone service should be able to secure it at once without the long delay which had hitherto interposed. He hoped the reply from the Secretary to the Treasury would show that the Post Office was alive to the importance of the subject, and would not allow a monopoly to grow so huge that it would be impossible to touch it, but would by competition of other companies, or through the Post Office itself, secure to London those telephone advantages towns in America enjoyed.

Sir James Fergusson (Manchester, N.E.), as a director of the National Telephone Company, offered such explanation as he could give on the case put forward by his hon. friend. During his term of office as Postmaster-General it was his business to devise a system by which the telegraphic revenue of the country should not be injured, while facilities were given to companies licensees of the Post Office to develop the telephone system. Up to that time there was practically only one company to deal with, and after long negotiations arrangements were made, made known to the House, embodied in a Treasury minute, and referred to a Select Committee. While, on the one hand, the trunk wires were by consent to be purchased by Government, the company were afforded the right of acquiring wayleaves, with the safeguard that the Post Office refused to grant any monopoly, reserving the power to issue new licenses, or to establish exchanges of its own. The consent of local authorities and individuals to carry wires across public and private property had been the difficulty the company had had to contend with, and had prevented them from making the service as efficient as they desired. Local authorities had been slow to afford facilities, and individuals had been most exacting. Such was the case in reference to mansions in Victoria Street, to which the hon. member had referred. The Post Office had power, which the company had not, to appeal to the Railway Commissioners to overrule the opposition of local authorities. He was glad, however, to say that the difficulty was in a fair way to be removed by an agreement with the County Council to allow of all wires being laid underground. The company had a large number of subscribers, 4,000 in the City alone, and telephones were used on an average 12 times a day. The company could not be fairly charged with parsimony, for in three years they expended £300,000 in converting the original single wire system into a duplicate system, and since that had been done complaints had been reduced 80 per cent.

Mr. E. Lawrence (Cornwall, Truro) said the Post Office would not be justified in undertaking a large expenditure in the direction indicated, because there would be soon before the public a new system of telephony without any connecting wires whatever. It was confidently expected that the invention would be successful, and would revolutionise the whole system of telegraphy and telephony.

Mr. Hanbury was not surprised at the demand for a more efficient telephone service in which this country was not up to the level of some foreign countries. The Government were determined that such an efficient service should be secured, and if, as the result of independent public inquiry, any particular service was shown to be inefficient or too costly they would exercise their right to institute a rival service or establish a Post Office telephone exchange. One conclusion, at any rate, the Government had arrived at, and that is that they would not buy out the existing National Telephone Company. They had such a lesson with regard to the purchase of the telegraphs that they were certainly not likely to repeat the error. But that in itself was not a sufficient way of meeting the case, for undoubtedly the National Telephone Company would go on extending their system in many directions, and unless the Post Office, either through exchanges of its own or through those of corporations, put itself in a position to take over and work the telephonic communication of the country when the concession to the National Telephone Company ceased in 1911, they would be in a very considerable dilemma, and might have to buy the company out at their own price. But that, again, was a danger which they certainly did not intend to incur. At any rate, in regard to London, the complaints with regard to the telephone service that had reached the Post Office had been very few, but it must be remembered that the Post Office had no means of ascertaining officially what the company was doing, and he did not think the public yet realised that in the last resort the appeal was to the Post Office. He was bound to say that the decrease in the number of complaints was a considerable tribute to the way in which the company was doing its work. Up to 1893 there were numerous complaints of the cost of the service and the difficulty of communication, but in that year the company began to extend the twin-wire system, which, except in a few outlying districts, was now in use throughout the metropolis. At the same time, the cost to private houses was reduced from £20 to £10, and, although the charge to places of business was maintained, facilities were given for contracting for five years, and in that case the charge was reduced from £20 to £17. No considerable complaint had been made of these charges, and he did not think they could be said to be excessive. In 1895, when the Select Committee was sitting, complaints were made by the Corporation of London and the London County Council, chiefly as to the difficulty of hearing the messages and of getting into communication. These difficulties had been so far got over that he understood the London County Council was now anxious to co-operate with the company. If the County Council gave the company facilities for carrying its wires underground, a great advance would have been made. He did not think his right hon. friend was right in saying that the County Council had the absolute right to give permission to take up the streets. It rested, in the first instance, with the vestries, and in the City with the Commissioners of Sewers; but, if they refused, the County Council could take them before a magistrate and then before the Railway Commissioners, and the onus of proof lay upon them to show that their conduct in refusing was reasonable. At present any complaints of the telephone service arose from the difficulty the company had in procuring wayleaves. So far as the overhead wires were concerned, they were entirely dependent upon the written permission of private owners. This difficulty had very largely impeded their work, and he hoped, with the co-operation of the County Council, it might be removed by the adoption of a system of underground wires, which, after all, was a much better system than any system of overhead wires. As to the question how far the company had endeavoured to meet the requirements of London, he found that it had about 16,000 subscribers, of whom 7,000 were in the City. It was a fair proof of the satisfaction the company was giving in the City, that of 29,000 occupiers 25 per cent. were subscribers. There were in London 150 call offices, where persons who were not subscribers could use the wires for a small charge. The number of these offices, he thought, was rather small. The company had not yet carried out the conditions imposed upon them two or three years ago, but he was informed that they were taking long strides towards getting over that part of the ground. It was the determination of the Government that they should have effective telephonic communication, not only in London, but throughout the length and breadth of the land. They could not afford, as a great business nation, to fall behind other nations. He could go further, and say it was not the intention of the Post Office to sacrifice the telephones to the telegraphs, and wherever, on complaint, it was found that there was a *prima facie* case that the service of the National Telephone Company was inefficient or too costly they would institute a public and independent inquiry, and, if the case was proved, they would set up another service in its place.

## AN INDUCTION COIL FOR X RAYS.

Since sending a note of a new method of operating an induction coil by the discharge of a condenser,* we have used it for operating X ray tubes, and find it gives us a much more powerful means of driving than any method we had heretofore tried. An exposure of one second gives an excellent negative of such common test objects as coins in a purse, and an exposure of five seconds is sufficient to give a negative showing clearly all the bony structure of the hand and wrist, a negative sufficient for the purposes of a surgeon. The best negative of the hand is to be obtained in about 20 seconds, and 45 seconds gives a marked over-exposure. Not only the bones, but the outlines of the cartilaginous and fatty tissues, and the tendons, are shown in a negative from a 25 seconds exposure. We have not had any opportunity to take any photographs through the body, but judging from results given by the fluorscope this method gives a far greater penetration of the rays and a much sharper outline of the shadows than any other we have used. The fluorescence is absolutely steady; the pulsations of the heart can be seen with startling clearness, and the outline of the liver and lungs may be sharply distinguished. The details of the bony structure of the trunk are also clearly shown. The ribs appear as tubes rather than solid rods, owing perhaps to the outer portion being more dense than the inner. The processes on the spinal column are well marked. The hand of the observer may be held between the patient under examination and the tube, and a clear image of its bones may be seen even through the most dense portions of the trunk.

The tungstate of calcium crystals glow so brightly as to make the screen have a distinctly granular appearance. Each crystal seems to be separately illuminated like the grains of sand on a piece of coarse sand paper placed in the bright sunlight.

The effect of prolonged running on the tubes is very similar to that of a static machine, only more pronounced. The resistance of a tube may be increased by running with closed spark-gap, making the concave electrode cathode as usual. If the tube be reversed the resistance will be lowered. It is very often found that a tube which has been run hard for some time when allowed to cool will increase in resistance, so as to be beyond the range of the coil. By running such a tube, making the concave electrode anode on the coil a few minutes, the resistance will be lowered. Slight warming will facilitate matters. Again reversing the tube and running with closed spark-gap, the tube may be brought back to its maximum efficiency in a very few minutes. We have repeated this operation five or six times on some of our tubes with good results. It is needless to say that the above applies only to focus tubes with a platinum anode.

The part played by the spark-gap is not yet clear to us, but we have noted the following observations: A spark-gap between spheres is better than one between points. Some tubes will run without a

* See Electrical Review for March 26th.

spark-gap, but when the gap is used it should be on the cathode end of the tube. The proper adjustment of a spark-gap may increase the intensity of radiation several hundred per cent.

The platinum anode in the focus tubes which we use becomes red hot, and the whole tube feels warm to the hand. This is true of tubes which do not heat when driven by a 12-plate 26-inch Wimshurst machine.

As stated in our note of February 17th, we are operating our induction coil by discharging through its primary a condenser which has previously been charged at 220 volts from the lighting mains. This charging and discharging we now accomplish 250 times a second by means of a five-part commutator on the shaft of a small motor. Since the condenser is disconnected from the mains only when it has risen to their voltage, there is no sparking when it is disconnected; and since the discharge of the condenser is exceedingly rapid, it has entirely passed before the commutator segment has left the brush leading to the primary. In other words, the condenser brush leaves its commutator segment when both are at 220 volts, and the coil brush leaves its commutator segment when both are at zero. Hence no sparking need occur on the commutator except the slight spark of making circuit.

The great increase in voltage at the terminals of the secondary over that given by the same coil when operated in the ordinary manner is probably due to the exceeding rapidity of discharge of the condenser, and hence the rapid change in the number of lines of force enclosed by the secondary. For each discharge of the condenser there must be a rise and fall of the current in the primary of the induction coil; but, since we get a uni-direction discharge at the secondary, one of these alone, either the rise or fall, must be effective. The reaction of the secondary of the coil tends to increase the rapidity of rise of current in the primary, but tends to retard the fall; moreover, at the instant the condenser is connected to the coil we have 220 volts, the potential of the condenser, applied to a circuit of exceedingly low resistance and very small induction, and from this we must get an extremely rapid rise of current. From these considerations alone it appears probable that the secondary discharge is due to rise rather than to the fall of current in the primary.

The volume of the discharge is so great that the ends of the secondary bristle with brush discharges, even when the terminals are within sparking distance of one another, and great care must be taken in insulating the primary from the secondary. There seems, moreover, to be a continual brush discharge from turn to turn of the primary, the nature of which we are unable to determine. If the iron wire of the core be put in a glass tube, and the primary be wound in a single layer about it, and the whole enclosed in a second larger tube, and the space between the tubes be filled with oil, the needed insulation is given.

Charles L. Norton.
Ralph R. Lawrence.

Rogers Laboratory of Physics,
Massachusetts Institute of Technology (Science),
Boston, *March 5th*, 1897.

## LEGAL.

### Hodge *v.* Tressler.

In the Official Referee's Court on April 1st and 2nd, the case of Hodge *v.* Tressler came on for hearing before Mr. Hemming, Q.C. Plaintiff, Mr. Laurence Fox Hodge, of the Tokenhouse Buildings, City, a member of the London Stock Exchange, sued defendant, a financial agent carrying on business in Gracechurch Street, E.C., for the recovery of £110 money had and received from the plaintiff by the defendant. Mr. Disturnal and Mr. Glasgow were for the plaintiff, and Mr. M. Macnaghten appeared for defendant.

It appeared that in April, 1894, defendant wrote to plaintiff informing him that he held certain interests in a German patent for the purpose of renewing incandescent electric lamps, and suggested to Mr. Hodge that it would be a good thing if money could be found to form a syndicate to acquire the patents and promote a company for their introduction and use. A circular was issued from defendant's office which set forth:—"It is proposed to raise by a syndicate the sum of £500 to cover initial disbursements," for which the terms offered were the return of the money invested, together with a bonus of £100 in cash and £100 in shares for each £100 invested, or *pro rata* for smaller amounts, both capital and bonus being payable upon the company going to allotment, which it was expected would be in about a month from the issue of the circular. As to the object of the syndicate, that was described in the circular as being:—"To bring out a company with a nominal capital of £100,000 to acquire and deal with Messrs. Merler's patents respecting a method of renewal and preparation of incandescent lamps." Certain negotiations followed, resulting in plaintiff advising two of his clients to invest £110, and paying over to defendant his own cheque for that amount. In May, 1895, plaintiff learned from defendant that the project was defunct, which statement defendant subsequently confirmed in writing:—"This syndicate is defunct, negotiations having unfortunately led to no practical results, and the funds being exhausted, the matter had to be dropped." In August, 1895, a statement was obtained from defendant, showing that only £390 had been subscribed, and that the whole had been expended. Commenting on this statement, Mr. Disturnal pointed out that on two occasions £12 10s. was drawn from the account opened in the name of the Electric Lamp Renewing Syndicate at the Capital and Counties Bank in favour of a Mr. Corbett, who it was suggested was the landlord of defendant's office. Counsel submitted that defendant entered into a contract representing that he had got £500 subscribed, and in consideration of which he would apply his own time, skill and energies to the promotion and getting out of the company; whereas it appeared he had not obtained the whole £500, and under the circumstances defendant ought to have gone to Hodge and the others and enquired what he was to do, whereas, Mr Disturnal contended, defendant had, in point of fact, put the money into his own pockets.

Plaintiff, in cross-examination, said he was not aware that the Swan-Edison patents expired in July, 1895.

The Official Referee: Everybody knows that.

Mr. Macnaghten: That is really what made this syndicate a failure.

For the defence it was argued that the subscribers to the Syndicate were partners, or certainly co-adventurers; that plaintiff, as agent, could not sue; and that the only action was for an account which counsel was prepared to go into.

Defendant did not appear on either day.

Mr. Disturnal said he was willing to allow defendant £10 as plaintiff's proportion of any expenses he might have had to incur in connection with the syndicate, and

The Official Referee gave judgment for plaintiff for £100, with costs of the whole action.

### Gamage *v.* Marshall.

In the Lord Mayor's Court last week, before Sir Forrest Fulton, Q.C., the Common Serjeant, and jury, this case was heard. It was an action for damages for breach of contract brought by plaintiff for underwriting 40 shares in the London Electric Omnibus Company, Limited.

Counsel said that early last year Mr. Marshall was bringing out the London Electric Omnibus Company, and entered into an arrangement with the plaintiff to underwrite 400 shares, for which it was agreed that he should receive 5 per cent. in cash and 10 per cent. in fully paid-up shares. He was eventually required to take up 160 £1 shares, 10s. paid. For about a fortnight in November last there was a great boom in this sort of shares, and plaintiff was able to dispose of the 160 alloted to him, but at the present time they were practically unsaleable. Although he had applied several times for his commission he had not yet received it. In the boom he was able to sell his 160 £1 shares, 10s. paid, at a premium of 3s. 1½d., so that if he had had his 40 shares for commission he would have made £46 more.

After hearing counsel for the defence, the Common Serjeant said that the action was practically undefended, and the only question was that of damages. He found altogether for the plaintiff for £66 5s., including the sum of £20 paid into court.

## BUSINESS NOTICES, &c.

**Agency.**—Mr. Archibald Campbell, of 28, Gray's Inn Road, E.C., has been appointed London agent of the Universal Electrical Fittings Company of Sheffield.

**Bankruptcy Proceedings.**—A sitting of the London Bankruptcy Court was held last week for the public examination of Wm. Alan Fraser, electrical engineer, late of 18, Cecil Court, Charing Cross Road, and 102, High Street, Guildford, who applied to pass upon accounts showing debts £904 10s. 7d., and assets £15 18s. In the course of his evidence the bankrupt said he traded in partnership at Cecil Court from May to August, 1895, and then alone for the next 12 months. The business was unprofitable, and was abandoned at the latter date. Between November, 1895, and July, 1896, he also had a branch business at High Street, Guildford. The trading there was unprofitable throughout, and resulted in a loss of about £150. The loss on the Cecil Court business since August, 1895, was about £86. The examination was concluded.

The first meeting in *re* G. F. Lee, of Wandsworth Bridge Road, and carrying on business as an electrical engineer, under the style of Lee & Hancock, at 111, Sydney Street, Chelsea, will be held at Bankruptcy Buildings, Carey Street, at 12 o'clock, on April 13th, the date for the public examination being May 21st, at 11.30 a.m., at the same place.

**Business Announcement.**—Messrs. J. P. Hall & Co., of Oldham, inform us that Messrs. J. P. Rushworth & Co. have ceased to act for them as Bradford agents; all inquiries and orders should therefore be sent direct to them at Oldham for the present.

**Cutting's Cord Grip.**—This cord grip, which is made by Messrs. Cutting Bros., of Derby, will, it is claimed, in any position hold any weight that can be sustained by the cord itself. By its use the two wires are kept widely apart, thus insuring high insulation. It facilitates the adjustment of the length of cord, as it can be easily slackened. The cord has only to be slipped through the holes in the disc. The weight of the pendant causes an instant and permanent grip. The whole weight is sustained by the grip itself upon the porcelain. There is stated to be no friction of the cord in process of fixing, thus injurious abrasion and consequent fear of disconnection is avoided.

**Ediswan Fittings.**—The Edison & Swan United Electric Light Company has issued a supplementary fittings list, dated April. The articles described in this 30-page pamphlet are ball fittings, cable connectors, cigar lighters, staples, ebonite pushes, reflectors, and various small accessorial apparatus requisite in connection with electric light fitting.

## Electrical Wares Exported.

| Week Ending April 6th, 1896. | £ | s. |
|---|---|---|
| Albany. Teleg. mat. ... | 607 | 0 |
| Amsterdam ... ... | 70 | 0 |
| Antwerp ... ... | 20 | 0 |
| Boca. Teleg. mat. ... | 28 | 0 |
| Bombay ... ... ... | 356 | 0 |
| „ Teleph. mat. | 30 | 0 |
| Buenos Ayres ... ... | 204 | 0 |
| „ „ Teleg. mat. | 126 | 0 |
| Cape Town ... ... | 53 | 0 |
| Colombo ... ... | 22 | 0 |
| Delagoa Bay ... ... | 85 | 0 |
| Flushing ... ... | 6 | 0 |
| Fremantle. Teleg. mat. | 1,787 | 0 |
| Gothenburg. Teleg. wire | 18 | 0 |
| Hamburg ... ... | 35 | 0 |
| Hong Kong ... ... | 115 | 0 |
| Melbourne ... ... | 105 | 0 |
| Odessa. Teleg. mat. ... | 25 | 0 |
| Otago ... ... ... | 13 | 0 |
| Port Elizabeth ... ... | 12 | 0 |
| Reval ... ... ... | 982 | 0 |
| Singapore ... ... | 245 | 0 |
| Sourabaya ... ... | 30 | 0 |
| Sydney ... ... ... | 20 | 0 |
| Wellington ... ... | 187 | 0 |
| Yokohama ... ... | 100 | 0 |
| Total | £5,281 | 0 |

| Week Ending April 6th, 1897. | £ | s. |
|---|---|---|
| Albany ... ... ... | 32 | 0 |
| Alexandria. Teleph. mat. | 61 | 0 |
| Amsterdam ... ... | 175 | 0 |
| Antwerp ... ... | 22 | 0 |
| Bilbao ... ... ... | 32 | 0 |
| Bombay ... ... ... | 13 | 0 |
| Brisbane ... ... | 150 | 0 |
| Brussels ... ... | 918 | 0 |
| Buenos Ayres. Teleg. cable ... ... ... | 4,495 | 0 |
| Bundaberg ... ... | 15 | 0 |
| Calcutta ... ... | 691 | 0 |
| „ Teleph. mat. ... | 44 | 0 |
| Cape Town ... ... | 185 | 0 |
| Cologne ... ... ... | 28 | 0 |
| Colombo ... ... | 20 | 0 |
| „ Teleg. mat. ... | 24 | 0 |
| Copenhagen. Teleg. mat. | 23 | 0 |
| Delagoa Bay ... ... | 50 | 0 |
| Durban ... ... ... | 165 | 0 |
| Flushing ... ... | 14 | 0 |
| Fremantle. Teleg. mat. | 6,318 | 0 |
| Hong Kong ... ... | 50 | 0 |
| Jersey. Teleg. mat. ... | 35 | 0 |
| Malta. Teleg. cable ... | 8,280 | 0 |
| Ostend ... ... ... | 25 | 0 |
| Paris. Teleg. mat. ... | 26 | 0 |
| Pernambuco. Telegraph cable ... ... ... | 9,000 | 0 |
| Port Elizabeth ... ... | 119 | 0 |
| Rangoon ... ... | 10 | 0 |
| Singapore ... ... | 156 | 0 |
| „ Teleg. cable | 14,109 | 0 |
| Stockholm ... ... | 8 | 0 |
| Sydney ... ... ... | 315 | 0 |
| Wellington ... ... | 254 | 0 |
| Yokohama ... ... | 143 | 0 |
| Total | £46,005 | 0 |

## Foreign Goods Transhipped.

| | £ | s. |
|---|---|---|
| Wellington ... ... | 675 | 0 |
| Total | £675 | 0 |

| | £ | s. |
|---|---|---|
| Sydney ... ... ... | 66 | 0 |
| Total | £66 | 0 |

**Electric Organ.**—A new organ which has just been put into the new McEwan Hall of Edinburgh University, was constructed at a cost of £4,000 by the Electric Organ Company, Limited, of Birkenhead, from the specifications of Mr. R. Hope-Jones, M.I.C.E., managing director of the company.

**Foreign Competition in South Africa.**—The *British and South African Export Gazette* for April publishes a series of striking tables, together with a diagram, showing the enormous progress which has been made by foreign countries in their trade with the South African States and Colonies. During 1896, the total oversea imports into South Africa amounted to £25,498,309 (the highest yet recorded) as against £16,081,708 for 1895. Of the former amount, Great Britain shipped goods to the value of £16,429,705, which is an increase of 34·4 per cent.; but competing countries such as the United States, Germany, Holland, Belgium, and France, taken collectively, have nearly doubled their trade, which stands at 102·1 per cent. for 1896, as against 54·6 per cent. in the previous year. In the case of the United States, the imports have increased from £1,009,318 in 1895 to £2,411,650 in 1896; Germany, £828,617 to £1,264,537; Holland, £169,039 to £225,990; Belgium, £136,546 to £373,861; and France, £44,727 to £146,390. These statistics, which have been carefully compiled by our contemporary from the official returns issued by the various South African States and Colonies, reveal the uncomfortable fact that while the proportion of British imports into South Africa has declined by 10·1 in the past six years, that of our rivals has advanced by 13·6 per cent. It is worthy of note, as showing the hold Germany now has upon South Africa, that its commerce with that market has successively doubled itself in each of the past six years. We do not know the extent to which electrical orders are represented in these figures, but we should imagine German electrical imports into South Africa are considerable.

**I. R. Arc Lamps.**—Notwithstanding competition, Mr. A. W. Richardson, of Patricroft, states that the I. R. lamp is pushing ahead. Further improvements are being made in the construction of the lamp, which have in view the simplification of the mechanism, and at the same time the retention of high class burning qualities. Additional special machinery is being put down for the manufacture, and the prices are to be reduced.

**Liquidation Notices.**—At meetings of the West Coast of America Telegraph Company, Limited, held on March 19th and April 3rd, it was resolved that, for the purpose of reconstruction, the company be wound up voluntarily, Mr. F. L. Robinson being appointed liquidator for that purpose.

**Theft.**—William Taylor has been sentenced to four months' imprisonment for stealing nine electric arc lamps from premises in Renfield Street, Glasgow.

**The Jandus Arc Lamp.**—A new list, dated March, 1897, has just been issued by the Jandus Arc Lamp and Electric Company, Limited, giving over 20 pages of testimonials received from all parts of this country, and also several places abroad, from those who have had the lamps in use.

## ELECTRIC LIGHTING NOTES.

**Aberdeen.**—On Saturday last the Gas and Electric Lighting Committee had a conference with Prof. Kennedy on the subject of the proposed extension of the electric lighting undertaking. There were submitted reports prepared by Mr. Alex. Smith, gas manager, and Mr. Alfred Blackman, electrical engineer, to the Corporation. During the past winter the electricity mains have been taxed to their utmost, and it has become necessary that their capacity should be increased. Two schemes were submitted dealing with the subject, and Prof. Kennedy, after hearing the committee, recommended the adoption of one of them. In this scheme the proposal put forward is to change the three-wire system of 110 and 220 to one of 220 and 440 volts. The estimated cost would be £357. The consumers at present using arc lamps might, it is anticipated, be induced to run them four in series in place of two in series. Failing this, the Corporation would have to supply them with arc lamps of a different type, at an estimated cost of £572. In addition to this, the Corporation would have to replace sundry switches and fuses, and generally put consumers' premises in a fit condition for the double pressure, at an estimated cost of £475. The amount which will thus have to be spent on consumers' premises is about £1,404. It is estimated, however, that the cost would be considerably lessened by the sale of the arc lamps at present in use. With regard to the mains, it is reported that they are in as good condition as on the day they were laid. As the present battery is very small for the requirements, it is proposed that it should not be interfered with, but utilised to feed one side of the system, and an entirely new battery of a similar capacity put in to feed the other side of the system. During the past three and a half years, batteries have very much improved, and the proposed new one, while it would cost about 15 per cent. less than the old one, would only occupy 55 per cent. of the space, and would be greatly reduced in weight. The total expenditure is estimated at £3,754, and the capacity of the mains will be increased by 22,000 lamps. The reporters think the importance and significance of this scheme cannot be overrated, and they consider it to be the first step towards the supply of electricity to the west end and to greater Aberdeen generally. The cost of the mains for the lighting and supply of power to the harbour had been estimated at £6,700, on the assumption that the supply would be at the present pressure. If, however, by the scheme now suggested the electric department were enabled to supply at double that pressure, the mains would cost only £4,810, a saving on the harbour lighting alone of £1,890. It is proposed that the work in consumers' houses should be carried out by workmen in the employment of the Corporation, who would be specially taken on for the purpose.

**Belfast.**—At the last City Council meeting, it was stated that Prof. Kennedy had declined to act as consulting engineer or to advise on any plans or specifications that he has not prepared. This statement referred to the previous decision to refer the proposals of the city electrical engineer, Mr. M'Cowen, regarding the new electric light station, to Prof. Kennedy to report thereupon. It is now stated that the Electric Committee proposes, in view of the Professor's reply, to proceed with the extension of the present system without employing a consulting engineer.

A meeting of the Council is to be held on Monday, to consider a recommendation of the Electric Committee that application be made to the Local Government Board for raising a loan of £70,000 for the purpose of the electric lighting scheme.

**Bristol.**—The Docks Committee has resolved to purchase a new dynamo for the electric lighting at the cold stores at Cumberland Basin.

**Cambuslang.**—Some days ago a deputation from Cambuslang visited Fort William to get information as to the electric lighting of that town.

**Cardiff.**—Mr. Applebee having reported regarding the necessity for electric lighting extensions, the Electrical Committee thinks it advisable to put down two machines with a combined capacity of 8,000 lamps, also the necessary engines and boilers—about 1,000 H.P. The Committee has asked Mr. Harpur to prepare plans and estimates for buildings, and Mr. Applebee to prepare specifications and estimates for the machinery required.

**Derby.**—At Wednesday's meeting of the Town Council, the Electric Lighting Committee was to bring forward its report which was presented to the Council on March 3rd, but which was not considered owing to the Council adjourning. The Committee ask for an additional £20,000 for new machinery, mains, and services, &c.

**Dundee.**—Mr. Ballingall reported to the Gas Committee the result of his negotiations as to the lighting of the new Post Office by means of electricity. He stated that the amount of current necessary for lighting the buildings throughout would be 20,000 to 30,000 units per annum, and he recommended that a charge of 3½d. per unit be made for a minimum of 2,0000 units. This was agreed to.

**Gloucester.**—The City Council has appointed a special committee to consider what steps should be taken by the Corporation under the Gloucester Corporation Electric Supply Order, 1896.

**Haltwistle.**—At the last Parish Council meeting a discussion, opened by Mr. J. Jackson, took place on the question of introducing the electric light. Nothing appears to have been decided.

**Hemel Hempstead.**—The Bury Flour Mills are now lighted throughout by electricity.

**Liverpool.**—The Lighting Committee of the City Council has decided to adopt a scheme for the extension of electric lighting in Liverpool, the total cost being £22,000. From the electric supply station at Lark Lane mains are to be laid to Mossley Hill, from the supply station in Oldham Street to Low Hill, Prescot Street, and Kensington, and from the station in Highfield Street to Everton, and along Scotland Road, mains being at the same time laid to the new free library in Everton, and the City Hospital, North Netherfield Road. It was further decided, at a cost of £950, to extend the facilities for electric lighting along Granby Street and Prince's Boulevard. From all the districts mentioned very numerous applications have been received.

The Committee have decided to reduce the price of street lighting by electricity to 3d. per unit, the reduction dating from April 1st. Sixteen electric lamps are to be erected in Prince's Boulevard, at an initial outlay of £720, the annual cost of the supply being estimated at £295.

**Lynn.**—An electric light installation has been put in the timber works of Messrs. Thompson, Pattrick & Woodward, of Lynn, comprising an 8-H.P. steam engine, supplied with steam from one of the mill boilers, and driving by belt a compound wound dynamo capable of lighting 150 16-C.P. incandescent lamps. The installation was put in by Mr. F. W. Dickinson, of Leeds.

**Peterborough.**—Once more the Town Council has shelved the electric lighting question, this time for a period of 12 months.

**Portsmouth.**—On the 2nd inst. Mr. L. Walton, C.E., held a Local Government Board inquiry touching an application to borrow £10,000 for electric lighting. It appeared from the statements of the Town Clerk, Alderman G. Ellis, J.P., chairman of the Electric Lighting Committee, and Mr. Manville, C.E., that £700 was required for the purchase of two freehold houses adjoining the electric lighting station, in order that a new boiler house might be erected there; £5,000 for additional accumulators and generators, and £3,000 for a duplication of the feeders from the station to King's Road, and from the station to Charlotte Street. Mr. Ellis, replying to a question by the Inspector, said that already the electric works were supplying 34,000 lights, independently of the 260 arc lamps in the streets. The Town Clerk said that £600 was required for six additional transformers, and the balance was for street openings and contingencies. There was no opposition. At a meeting of the Committee the same day, it was decided to reduce the price of current to consumers from 5d. to 4½d. per unit, the reduction to take effect from March 31st.

**Provisional Orders.**—The Board of Trade have decided to grant a provisional order to the Corporation of Brighouse to supply electricity within the borough at a capital outlay of £10,000. The board have also decided to issue a similar order to the Corporation of Morley, who will be authorised to expend £15,000 upon electric lighting.

**Rochdale.**—A sub-committee has viewed the electric lighting works at Burnley, Bury, Blackburn, and Bolton, and come to the unanimous conclusion that it is desirable for the Rochdale Corporation to apply as early as practicable for Parliamentary powers to carry out the work of lighting by electricity a section of the town. In addition to this they deem it desirable that in designing the works and plant for lighting purposes the engineer be instructed to have regard to the probable need of the generation of electrical power for working the tramcar system in the borough. The Corporation has approved of these recommendations.

**Sheffield.**—The question of the purchase of the undertaking of the Sheffield Electric Light and Power Company by the Corporation is to be brought before the latter body by one of its members.

**St. Helens.**—The question of an extension of the mains for the supply of electric light within the borough of St. Helens has been under the consideration of the Gas and Lighting Committee, and it has been decided to extend the mains along Bridge Street, and Corporation Street. The tender of the British Insulated Wire Company for the supply of 1,000 yards of low tension cable was accepted.

**Tunbridge Wells.**—The Borough electrical engineer, Mr. Boot, at the last meeting of the Electric Lighting Committee reported that for the month of March, 1897, applications were received for 946 lamps, a higher rate of increase than they had ever had since the works were opened. This brings the total number to over 13,000, with 288 consumers on the register.

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Birmingham.** — The deputation which visited the Continent, *re* electric tramways, has issued its report, recommending that no permission should be given to the Birmingham Central Tramway Company for the erection of overhead electric wires for tramway traction in any part of the city. They consider the conduit system most suitable. On Tuesday the Public Works Committee received a deputation from the Tramway Company with reference to the Committees decision.

**Bray.**—A special meeting of the Bray Commissioners was held on the 29th ult. in the Town Hall, as grand jurors of the township, for the purpose of inquiring into the proposal to construct tramway lines in the town and run electric cars. The promoters of the scheme were represented by Mr. D. B. Sullivan, Q.C., and Dr. Day, B.L. (instructed by Messrs. Molloy and Molloy), Messrs. Michael Nugent, Emile Garcke, managing director British Electric Traction Company, Limited; Thomas Nevins (Messrs. Nevins & Son, American railroad contractors). Mr. Emile Garcke stated that his company carried out such undertakings as the one under consideration in England and elsewhere. His company took an interest in the proposed scheme, and were prepared, provided the Grand Jury passed it, to find the necessary capital to build and equip the line. If such conditions as a 5 feet 3 inches gauge or heavy wayleave rents, which would make the paying capacity of the lines doubtful, were imposed, his company would prefer to lose the money already advanced to the local company than to risk more. He might tell them that if they insisted on a high wayleave it would kill the scheme in so far as his company was concerned. His company was prepared to sink between £30,000 and £50,000 in Bray, and take all risks if they got fair terms, but if their estimate of £32,000 for construction was largely increased by the imposition of impossible conditions, they could not go any further in the matter, and the whole scheme, so far as they were concerned, would fall to the ground. Mr. Thomas Nevins stated that it would be a mistake on the part of the Commissioners to impose severe conditions. He had built hundreds of miles of electric railways in America, and he came to Ireland, as it was the land of his birth, to invest £500,000, but he found that the people were too slow and too much disposed to handicap investors and capital, and he was about to return to America. He would not be disposed to build the line they were considering if it was offered to him. In America promoters would be paid for introducing such a scheme into a district instead of being loaded with conditions. After a short consultation, Sir Henry Cochrane announced that the following resolution had been agreed to by the Grand Jury:—Proposed by Mr. Langton and seconded by Sir Rowland Fanning—"That the Commissioners, sitting as Grand Jurors, approve of the electric tram scheme on the conditions that the company, within six weeks or before the lapse of time of entering opposition to the scheme before the Privy Council, shall deposit a sum of £2,500 in cash or trust stock in the names of the chairman of the Bray Commissioners and one trustee for the company. To pay a wayleave of £5 a mile and 10 per cent. of all profits earned after paying ordinary shareholders 6 per cent. per annum. The company to pay the Commissioners the cost of maintaining the paved portion of the roads along which the tram lines would be laid. In the event of the undertakers adopting the overhead trolley wire system and using the rails as a return, the method of bonding the rails should be subject to the approval of the Commissioners. The company would not be allowed to use steam for locomotive purposes. The gauge of trams to be not less than 3 feet 6 inches, and the streets to be paved for a width of 9 feet. The duration of the lease or agreement to be for 42 years. That £2,500 be deposited within six weeks from this date in the names of the chairman of the Commissioners and one trustee for other side as a guarantee for the carrying out of the Promenade Pier project. Deposit to be made concurrently with the deposit required as guarantee in *re* electric tram project, and to be forfeited on terms in the event of project not proceeding. In default thereof the tramway scheme to fall through. That the Commissioners be at liberty to purchase the tramway undertaking at any time after a lapse of two years from the date of the agreement between the parties." The resolution was agreed to by the Grand Jury, and the proceedings terminated.

**Cardiff.**—The Electric Tramway Committee last week had before it the report of the borough engineer, Mr. Harpur, upon suitable routes for electric tramways, suggesting lines to Llandaff, Whitchurch, and Penarth, of a total length of 23 miles. Mr. Applebee, the Corporation electrical engineer, said it would be practicable to work any of the systems from the present electric lighting station, but he thought it would be more economical to erect another power station at the eastern end of the town. He was instructed to bring up a report as to the best system of electric traction, and as to the means of providing electric energy.

**Charing Cross, Euston, and Hampstead Railway.**—The Unopposed Bill Committee of the House of Commons, on Friday last, passed a Bill reviving and extending the powers for the construction of the underground electric railway from Charing Cross to Hampstead, which was originally authorised by Parliament in 1893.

**Douglas.**—A special meeting of the Town Council was held last week, when it was decided that a special committee and the town officials go to the Continent to see various electric lighting and tramway systems, it being understood that the deputations were also to have an opportunity of viewing the effect of incandescent lighting where extensively in use.

**Fire on an Electric Tramcar.**—The evening press of Tuesday stated that there was an outbreak of fire on an electric tramcar at the gates of the Parc Monçeau, Paris, the cause being attributed to fusion of wires. In the scare among the passengers, some of whom jumped from the car, several were injured.

**Glasgow.**—The electric tramway question is the subject of another report by Mr. John Young, the general manager of the tramways. He says: "That, having carefully considered the whole question, we recommend that the route from Mitchell Street to Springburn be equipped for overhead electric traction as indicated, and that with a view to providing in this way for the necessary augmentation of the service, which is sure to be required next spring, it be remitted to the Tramways Committee with powers to equip this route accordingly, as soon as they conveniently can. And we make the further suggestion that the Corporation remit to the Electric Lighting Committee, acting in co-operation with the Tramways Committee, to light electrically, as an experiment, a portion of the route, with a view to utilising the traction poles for lighting purposes." Mr. Young has prepared a report on Dublin and Isle of Man electric tramways, the "Simplex" system, and the Blackpool gas and electricity systems.

**Halifax.**—The Halifax Tramways Committee have decided to recommend the adoption of electric overhead traction for the Halifax Tramways, and that before considering the details of the system the Committee or a deputation visit Walsall, Coventry, and Bristol. The Committee further recommend that the Gas Committee be asked to consider the desirability of removing the lamp-posts on the tram routes, and lighting the streets by electricity from the tram-posts.

**Leeds.**—The Tramways Committee has decided to accept the tender of Messrs. John Fowler & Co. for the supplying and fixing of steam piping to the tramway generating station. Messrs. Fowler are also supplying the engines, &c. The order for 10 trailer cars, each to accommodate 46 passengers, has been placed with Messrs. Milnes, of Birkenhead, who have already supplied 25 ordinary electric cars. Six of the new cars will be supported on the "Brill" truck. The work of relaying the rails on the Chapeltown section, on which the steam cars taken off the electrical section are to be run, will commence next Monday.

**London.**—A report was presented at the last meeting of the Bermondsey Vestry, on Monday, by the General Purposes Committee, in reference to a letter received from the London, Deptford, and Greenwich Tramway Company, asking the Vestry's consent to the experimental running of a tramcar fitted with Ribbe's accumulators, on that portion of their line commencing in Rotherhithe New Road, at the junction of Raymouth Road, and up to the Canal Bridge, Old Kent Road, and stating all the other local authorities have given their consent. The Committee recommended, and it was decided, to grant the required permission for a period of six months.

**Norwich.**—The Norfolk County Council on Saturday last, on the recommendation of the Highways Committee, approved of the clerk lodging a petition on the Council's behalf against the Norwich Electric Tramways Bill, with the object of preventing a tramway being placed in the narrow parts of the main streets in Thorpe St. Andrew, which the county surveyor has reported as being wholly unsuited for a tramway, which if constructed would be both dangerous and inconvenient to the public.

**Speed of Electric Cars.**—In the House of Commons last week, Mr. Field asked the President of the Board of Trade whether he had received memorials asking for an acceleration of the speed of the electric trams running from Ballsbridge to Dalkey, and whether the Board of Trade will permit the same rate of speed as is allowed on other electric traction lines in Great Britain and Ireland. Lord George Hamilton (for Mr. Ritchie): Yes; the Board of Trade have received memorials on the subject, and are considering them. There is no uniform rate of speed for electric tramways. Each case must be dealt with on its merits.

**Sub-soil Rights and Underground Railways.**—At a meeting of the Kensington Vestry on Wednesday, April 7th, a letter was read from the Vestry of St. Martin-in-the-Fields, inviting the Vestry to appoint two delegates to attend a conference to consider the desirability of promoting legislation to provide for payment to the local authorities by promoters of railway and similar undertakings, of some monetary consideration for the right of user of the sub-soil of the streets.

**Swansea.**—The Brighton Town Council has agreed to allow Mr. Arthur Wright, corporation electrical engineer, to attend at Swansea to give evidence in support of a Bill being promoted by the Swansea Corporation for the provision of electric power for running tramcars.

**The Underground Electric Railway Schemes.**—The Select Committee of the House of Commons appointed to inquire into the London electric schemes met again on Wednesday. The evidence having been concluded on Monday last, the whole of the day was occupied by Mr. Littler, Q.C., in addressing the committee on behalf of the promoters of the Brompton and Piccadilly Circus Railway against the City and West End railway scheme. The committee were to meet yesterday afternoon to consider and announce their decision on the two schemes.

**The Isle of Thanet Scheme.**—At a meeting of the Ramsgate Town Council on Thursday evening, considerable discussion ensued in respect of the proposed electric railway, and by permission of the Council a deputation of some 40 gentlemen were admitted for the purpose of giving their views against the scheme of the Isle of Thanet Electric Railway Company. Mr. H. B. Hammond, J.P., first spoke, and urged that an electric railway carried on iron columns at least 18 feet high, as proposed, would disfigure the whole of the front of the East and West Cliffs, and would practically spoil what had cost the town very nearly £100,000 in carrying out. Other speakers urged the same sort of objection, after which the Council resolved to convene a special meeting to consider the attitude they should take up in the matter.

**The City and West End Railway.**—The Select Committee of the House of Commons, on Monday, resumed the consideration of this Bill, which provides for the construction of an underground railway from Hammersmith Broadway to Cannon Street, to be worked by electricity. Mr. Alfred Powell, manager of the District Company, gave evidence in opposition to the scheme. The District Company, he said, were promoting a Bill to construct a line passing under their existing line from Earl's Court to the Mansion House. Undoubtedly the public, especially for short distances, preferred an omnibus or car to an underground railway. To earn a dividend of 4 per cent. the new line would, at an average fare of 1d., have to carry 76,800,000 passengers; at 1½d., 57,600,000 passengers; and at 2d., 38,400,000; yet on the corresponding length of the District (from the Mansion House to Hammersmith) only 17,610,000 passengers were carried. Until the Central London line had proved successful, he held that it would be premature to construct any line such as the present. Sir Benjamin Baker, the engineer to the District Railway, further explained the District Company's scheme. On a train arriving at Earl's Court the steam locomotive, if the train were going along the deep level, would be replaced by an electric locomotive, and the train taken on to the City without the passengers having to change. The line would be nearly five miles in length, and at the stations there would be lifts from the low level to nearly the existing level of the stations. His estimate of the cost of the line totalled £881,400, and for land and buildings, including depôt for rolling stock, £25,000.

**Tramways and Electric Lighting Orders.**—The Highways Committee of the London County Council on Tuesday reported as follows:—"In accordance with the resolution of the Council of February 2nd last, we submitted to the Board of Trade a clause for the protection of the Council's tramways in the event of the adoption of electrical traction, and asked that such clause might be inserted in all electric lighting orders which might be granted in this and future years. We have now to report, for the information of the Council, that a communication has been received stating that the Board is unable to insert the proposed clause. The Board points out that the question of the relations between users of electricity for tramway purposes and other users of electricity was fully considered in 1893 by a joint committee of both Houses of Parliament, which settled a clause to be inserted in all Bills and provisional orders authorising the use of electricity on tramways, and that should the Council be authorised to adopt electrical traction on its tramways, the clause so settled will apply to them."

**Yarmouth.**—The electric tramway scheme of the British Thomson-Houston Company was revived in a somewhat revised form last week, and there was a lengthy discussion at a special meeting of the Council. The majority of the Councillors were, however, in favour of municipal tramways, and approval was withheld by 16 votes to 11.

## TELEGRAPH AND TELEPHONE NOTES.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| Brest-St. Pierre (Anglo, 1869) | April 6th, 1895 ... | ... |
| West Indies— | | |
| Puerto Plata-Martinique | Dec. 19th, 1895 ... | ... |
| St. Croix-Trinidad ... | Nov. 30th, 1896 ... | ... |
| Jamaica-Colon ... ... | Feb. 6th, 1897 ... | ... |
| Amazon Company's cable— | | |
| Parintins-Itacatiara ... | May 5th, 1896 ... | ... |
| Obidos-Parintins ... | Dec. 7th, 1896 ... | ... |
| Emden-Vigo ... ... ... | March 24th, 1897 ... | ... |
| **Landlines.** | | |
| Trans-Continental line beyond Mazol | March 12th, 1896 ... | ... |
| Carthagena - Barranquilla (Columbia) | July 4th, 1896 ... | ... |

**Glasgow Telephones.**—On 31st ult. a deputation from the Telephone Committee of the Glasgow Town Council waited upon the Postmaster-General, the Duke of Norfolk, and urged that the General Post Office should decide definitely as early as possible whether it would or would not comply with the request of the City Corporation for a telephone license, which had now been four years under the consideration of the Department. The deputation, which was accompanied by Sir Charles Cameron, M.P., Mr. Alexander Cross, M.P., and Mr. Provand, M.P., urged that as a matter of high municipal policy it was inexpedient that a private company, like the National Telephone Company, should have the right to interfere with the streets in order to lay the improved underground service that

was needed, that the corporation could supply an efficient service at half the price now charged by the company, and that if a license were granted to the corporation it would probably yield a greater revenue to the General Post Office than was now derived from the city. The Postmaster-General promised to carefully consider the matter and to give an answer as soon as possible.

**London-Paris Telephones.**—The newspaper press says that the preliminary arrangements are now complete for laying across the English Channel two additional telephone cables. The first cable will be laid shortly by the English cable ship *Monarch*, the second being laid by the French Government, for whom it has been constructed in France. The cables will leave the English side of the Channel about three miles to the west of Dover. There are two circuits in each wire, so that with the cable already laid there will be six wires available for public use instead of two as at present, which are in constant use. When the additional cables are duly installed, it is stated that facilities for international telephoning will be given to the large commercial centres in both England and France, instead of being confined to London and Paris only, as at present.

**Statesmen and Telegraphy.**—Elsewhere we publish an account of a selection from the papers of the late Earl of Carnarvon, who was Secretary of State for the Colonies. In connection with this it is interesting to note that Sir Robert G. W. Herbert, G.C.B., who was Under Secretary of State for the Colonies at the same time is also interested in cable matters; holding as he does the position of director on the board of the Telegraph Construction and Maintenance Company, Limited, and on that of the Eastern and South African Telegraph Company, Limited.

**The Deutsche See-Telegraphen-Gesellschaft.**—The following extract from a usually well informed contemporary furnishes an instance of how Germany is sometimes misunderstood in relation to her trade rivalry with this country. The *Globe* says: "Germany, like France, has begun to compete with us in the manufacture and laying of submarine cables. Quite recently a German company laid a cable between Emden, in Germany, and Vigo, in Spain. It is really the first section of a system of submarine lines which Germany hopes to lay in order to correspond directly with the two Americas and Africa. Hitherto German messages have had to pass over British and French lines." Although the name of the company owning the cable referred to is undoubtedly German, and the cable route is of advantage to that country, it is wrong to infer that the cable must necessarily have been "made in Germany," or indeed that the capital invested in this enterprise was furnished from that country. As a matter of fact, the cable in question was manufactured by the Telegraph Construction and Maintenance Company at Greenwich, and laid by them, and to a very large extent the capital, we understand, was supplied by the same company in conjunction with the Eastern Telegraph Company and the Brazilian Submarine Telegraph Company, both of which are English. This cable was opened to the public on January 1st last, since when it was interrupted for six days in February, and again broke down on the 24th ult., and we have not yet heard of its being repaired.

**The Rubber Forests of Upper Burma.**—Mr. H. N. Thompson, Assistant Conservator of Forests in Burma, in a recent report on the forests of the Hukong valley and the Upper Namkong basin, in Upper Burma, devotes a section to the production of rubber in that region. It appears, says the *Times*, that in the Hukong valley the rubber tree is not a gregarious one; sometimes a family group of four or five trees may be seen, but as a rule a mature tree is found every 200 or 300 yards in the richer forests. When the tree is surrounded by dense shade it grows to enormous heights in order to get at the light, and some of those examined by Mr. Thompson were the largest trees of any species he had ever seen. In the thick forest he found no seedlings in the ground; they were invariably growing at a great height on other trees and sending their roots down towards the ground, so that the roots finally formed great supports on which the main trunk rested, while the original tree on which the seedling was a parasite was destroyed. The difficulties of transport from the Hukong valley is increasing as the more accessible trees are being worked out. The Chinese have a practical monopoly of the trade here. The rubber is taken to Mogaung, a route across the mountains to Myitkina having been abandoned owing to the exactions of the Sana Kachins. The forests at the head of the Namkong are rich in rubber, and the tree attains a height of 200 feet, with an enormous girth. The Kachins go from far and near to collect the rubber in the dry season, and the chiefs levy toll on the produce as it passes down the rivers. The Chinese control the trade, selling provisions and cloth to the Kachins, who pay in rubber. The produce of the forests within the drainage area of the Tarou river goes to Assam, across the passes of the Patkoi mountains. The Nagas, having got in their crops in December, set off for the rubber forests, where they know every tree, the knowledge being in many cases passed on from father to son. Rubber in this district is said to be growing scarcer, and it often takes a man 40 days to collect a coolie load, although the Singpho villages levy a tax on each collector. When first collected the rubber is very pure, but the Nagas have acquired the trick of adulterating it with earth and stones, so that Assam rubber is not regarded with favour in the Calcutta market. The rubber that goes to Rangoon is also adulterated, the Chinese being adepts in the art of concealing stones in it. Mr. Thompson thinks it useless to apply legislative protection and regulation to these rubber forests, unless the districts were taken over and administered directly, for the Singphos are extremely independent and own no masters, while some of the chiefs told him they could not enforce rules or interefere with the collectors. But the protection of the trees growing within our own administrative sphere would be possible, though Kachin opposition would have to be dealt with.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Aberdeen.**—April 27th. The Corporation invite tenders for an electrical storage battery consisting of 125 cells of 400 ampere-hour capacity, also for battery regulating switches. City Electrical Engineer, Mr. A. Blackman, Cotton Street. See our "Official Notices."

**Bedford.**—The Electric Light Committee want tenders for the supply and erection of two water tube boilers with Vicar's mechanical stokers, alternating current motor, and steam piping. Particulars to be obtained of Mr. T. S. Porter, Town Clerk. See our "Official Notices."

**Belgium.**—April 29th. Tenders are being invited by the Provincial Government Authorities at Liège for the concession, maintenance, and working of an electric tramway on the overhead-conductor system, between Chenée and Grivegnée. Tenders to be sent to the Gouvernement Provincial à Liège.

**Brighton.**—April 12th. Tenders are wanted for the supply and delivery of armoured lead covered electric cables and jointing sundries.

**Edinburgh.**—April 10th. The Corporation want tenders for the supply of good steam coal for the electricity supply station from May, 1897, to May, 1898. Specification, &c., from the Resident Electrical Engineer, 5, Dewar Place.

**Jamaica.**—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

**Luxembourg.**—April 11th. Tenders are being invited by the Luxembourg Post and Telegraph Department for the supply of 40 tons of galvanised iron wire, 3,000 metres of insulated wire, 1 ton of bronze wire, and 1,500 porcelain insulators, &c. Tenders to La Direction des Postes et des Telegraphes, Luxembourg.

**Roumania.**—April 19th. The General Direction of the Roumanian Posts and Telegraphs in Bucharest is inviting tenders until April 19th for the supply of 55½ tons of iron wire.

**South Africa.**—April 17th. Tenders are being invited for the supply of a quantity of porcelain insulators and copper wire. Tenders to be sent to the Consul General of the South African Republic, 8, Doelenstraat, Amsterdam.

**St. Pancras.**—April 27th. The St. Pancras Vestry want tenders for the wiring, &c., in connection with the electric lighting of the Whitfield Street Baths and Washhouses.

**Wallasey.**—April 22nd. The Urban District Council want tenders for the supply for one year of sundry supplies, including paper insulated concentric cables; oils, lead and wrought-iron pipes, cast-iron main pipes; cotton waste, meters (gas, water, and electricity); lamp columns and lamps; main switches and cut-outs. Particulars on application at the Gas and Water Engineer's office, at the Works, Great Float, near Birkenhead.

### CLOSED.

**Belfast.**—The Corporation has accepted the tender of the Zurich Incandescent Lamp Company for lamps, and of the Edison and Swan United Electric Light Company for switches and fuses.

**Boston.**—The Boston Harbour Commissioners have selected for acceptance out of eight tenders sent in for fixing an electric light installation at the dock, that of Messrs. Spagnoletti and Crookes, of London, at £1,682. The estimate of Mr. A. Collins, the consulting engineer, amounted to £1,267.

**Bristol.**—For fitting up the offices of the Sanitary Committee for electric lighting, the tender of Messrs. F. W. Ball & Co., of Bristol, for £53 16s. 6d. was accepted.

**Cardiff.**—The following is a list of the tenders for wiring The Judge's Lodging, The Walk:—

| | £ | s. | d. |
|---|---|---|---|
| 1. Messrs. Clay Bros. & Co. (accepted) | 95 | 10 | 0 |
| 2. Messrs. Alger & Sons | 97 | 0 | 0 |
| 3. Messrs. Baker & Co. | 113 | 0 | 0 |
| 4. Messrs. Lewis & Fletcher | 135 | 0 | 0 |
| 5. Messrs. J. B. Saunders & Co. | 136 | 16 | 0 |
| 6. Messrs. Sydney Walker & Co. | 145 | 0 | 0 |
| 7. Messrs. Duncan Price & Co. | 148 | 10 | 0 |
| 8. Messrs. Hatcher & Co. | 170 | 0 | 0 |

**France.**—The Société d'Exploitation des Procédés Electriques "Walker" has just secured a contract for 17 electric motor cars for the Paris-Romainville electric tramway.

**Manchester.**—The Electric Construction Company, Limited, have just received an order from the Manchester Corporation for one of their continuous current multipolar dynamos coupled to a Musgrave engine of 2,500 I.H.P. This is believed to be the largest combination of the kind yet ordered in this country.

**Portsmouth.**—The Electric Lighting Committee have received tenders for the supply of accumulators, and for motor generators and switchboard. For the former eight firms tendered, the highest of these being £5,220. The lowest was £4,066 (Messrs. Pritchetts & Gold), apart from the charges for maintenance which varied considerably. It was decided to recommend the Council to accept the tender of Messrs. Tudor & Co., whose price is £4,200, they agreeing to maintain the accumulators free of cost for one year, at the expiration of which the Corporation may call upon the firm to continue the maintenance for three, five, or seven years at £245, £220, and £210 a year respectively. For motor, generator, and switchboard, four tenders were sent in varying from £4,250 to £1,188 15s. The latter, from Messrs. Easton, Anderson & Goolden, the Committee recommend for acceptance by the Council, subject to the loan applied for being sanctioned by the Local Government Board.

## THE INQUIRY AT WEST HAM.

On Tuesday last Mr. Baggallay held an inquiry at West Ham Town Hall on matters which had risen out of the acceptance of the electric lighting tenders. After setting forth the history of electric lighting in the borough, the receipt and adjudication of tenders, Mr. Baggallay referred to the letter of the Electric Construction Company, which is now too well known to be repeated. As a result of this and other newspaper correspondence, the Town Council asked the Local Government Board to hold an inquiry, but, on their declining, Mr. Baggallay, the stipendiary magistrate of West Ham, consented to hold the inquiry.

There was nothing of a judicial air about the proceedings, but they were nevertheless conducted with an amount of decorum that was quite in keeping with legal traditions.

Although there were many electrical contractors who had tendered, there was only one company represented at the enquiry, the Electric Construction Company being present in the persons of Mr. Barclay, the deputy chairman, and Mr. Gray, the secretary of the company. Mr. C. F. Gill appeared for the West Ham Town Council, while Mr. Hunns, a member of the Council, was represented by counsel.

In his opening remarks Mr. Baggallay said the main question was whether there was any improper conduct on the part of any member or members of the Town Council in connection with the acceptance of tenders. Mr. Barclay in addressing the Court on behalf of the Electric Construction Company, said they had desired to have some information as to the reasons of accepting those higher tenders, but they had had no reply, nor any particulars of tenders. He thought there was a moral obligation on the part of a Town Council to accept those tenders that were most advantageous to the borough.

Mr. Gray, the secretary of the Electric Construction Company, was called, and made a statement on the lines of the much quoted letter. He amplified it, however, by further details, the chief purport of which was that Mr. Paris called upon him on December 9th, 1896, and said if the Electric Construction Corporation wished to have the contract for West Ham, he could obtain the assistance of a member of the Corporation, who would have to be paid for his services. He (Mr. Gray) declined the offer, and Mr. Paris then remarked that other firms who tendered did not scruple to pay for assistance.

The cross-examination by Mr. Gill elicited the fact that Mr. Paris did not disclose the name of the councillor. Mr. Smith, accountant of the Electric Construction Company, said a gentleman called at the office one day, and in conversation told them to go in for the contract at West Ham. When asked the object of his visit, he produced two cards bearing the name of Hunns, and also said that he was a member of the West Ham Town Council. Mr. Gray was recalled, and in reply to Mr. Gill, said the above incident was reported to him, but he did not attach sufficient importance to it at the time, but taken in conjunction with the adjudication of the tenders, he thought it was important. He was aware that the West Ham Town Council did not bind themselves to accept the lowest tender, and they tendered with that knowledge. He admitted that the Electric Construction Company's tenders had been accepted when they were not the lowest, but did not think the difference was so great as in the West Ham instance.

Mr. Paris was next examined, and said that he had known Mr. Hunns for some years, and in November of last year met him by chance and learnt that the tenders were opened, and that the Electric Construction Company and others were well in the running. After leaving Mr. Hunns he went to the offices of the E.C.C., and suggested that if he were paid a commission he might be able to influence the order through a Town Councillor. He did not mention the name of the Town Councillor. The chief points elicited in cross-examination were that the witness thought he could influence Mr. Hunns to call upon the E.C.C., so that he might have the tender more fully explained. The chief admission of the witness was that he went to the E.C.C. without the knowledge and authority of Mr. Hunns.

The next witness called was Mr. Hunns, who said that he was an electrical engineer and contractor. He remembered calling upon the E.C.C. in September for orders, but did not suggest that if he got orders he would use his influence with the Corporation. He was a member of the committee which dealt with the electric lighting question; about the time the tenders were being discussed he remembered meeting Mr. Paris, but gave him no authority whatever to go to the E.C.C. He had not received any commission from Mr. Ferranti, and had never done work for him directly. In cross-examination he remembered calling a second time at the E.C.C. for a catalogue, and he was constantly callling at different electrical engineers, and may have called at Crompton's; very likely the subject of electric lighting at West Ham was mentioned. The only other point of importance elicited from the witness was, that the Committee accepted the recommendations of the engineer.

Mr. Steinitz, the Borough Electrical Engineer, was then called, and said that he very carefully considered the whole of the tenders and reported to the committee. He was not influenced in the smallest degree by corrupt motives, and had not been in communication with Mr. Hunns, or any other members of the Council. He recommended the tender of Messrs. Ferranti, in Section A, for £9,600, on the grounds of safety to the public and employés, the efficiency of the plant, the few complications, and because it would be least likely to break down. He was not influenced by any other wish than that the work should be ultimately successful. The witness was then examined on the various sections of the tenders. The report was accepted by the committee as a whole, and was adopted by the Council.

By Mr. Barclay: The specification was left as open as possible; he specified what the results were to be. He considered that the Ferranti alternator was more mechanical than the others submitted, and in other respects the machine was superior.

A question arose as to whether the witness should be asked to give his opinion upon the various machines, and Mr. Baggallay suggesting the inquiry should be as open as possible, Mr. Barclay then put a series of questions on the various tenders. Asked as to his experience, the witness said he had had four years; he had previously been employed as chief electrical engineer at Leicester. The witness said that after the tenders had been opened he wrote to Ferranti's, pointing out that their price was higher than what had been quoted in a previous letter. The price was then amended by Ferranti. Asked as to the tender for arc lamps, the witness said he had recommended a special type, but admitted that the lamp had not been used for alternating work, and it was in the nature of an experiment, but in the event of it failing the contractors had to supply him with lamps which were satisfactory to him.

After the evidence of the Mayor of West Ham, who expressed confidence in the engineer, Mr. Gill and Mr. Barclay spoke on the whole case.

Mr. Baggallay said it had been made clear that there was not the slightest evidence of corruption on the part of the electrical engineer, but whether he had been wise or not he should have to consider.

## THE TELEPHONE SERVICE.

Mr. Hanbury's reply to Mr. Bartley, as reported in another column, must be considered of some importance as indicating the intention of the Government not to purchase the existing Telephone Company, whilst still insisting upon an effective service being given. A public and independent inquiry is to be instituted wherever a *primâ facie* case is made out that the existing service is inefficient or too costly, and another service would be set up if the case were proved. This statement may encourage municipal or private movers in the telephone field; but it should be borne in mind that inefficiency and excessive cost, however generally charged, are very difficult to prove. If proved, there is unfortunately the fact that a limited tenure and a lack of experience would militate against the effectiveness of any private or municipal organisation. It results, therefore, that the matter becomes a Post Office one, as it ever has been, and the decision not to purchase the existing plant carries with it an obligation that the Post Office should itself set up the improved service where inefficiency is proved. There may be room for regret that fears of being mulcted in extravagant payments have prevented consideration being given to the acquisition of the existing plant at an early date. The determination of the Government to have effective telephonic communication throughout the length and breadth of the land may be attained in other ways, but the Government may remember the observation, attributed to the Duke of Wellington, that if one wants a thing done well one should do it oneself.

**Mr. Preece's Approaching Retirement.**—Mr. W. H. Preece, C.B., F.R.S., the engineer-in-chief at the General Post Office, has been interviewed by a *Daily Mail* reporter regarding the supposed tapping of telegraph cables by the s.s. *Oxus* mentioned in the daily press, and at the close of the interview he is stated to have remarked, "I have completed 45 years' experience with electrical matters, and after another 18 months' service it is my intention to retire, and enjoy the rest I feel is due to me."

## NOTES.

**Good Friday.**—The Electrical Review will be published on Thursday of next week, owing to the usual day falling on Good Friday. Advertisers and contributors will please note, and supply copy one day earlier.

**Electricity on a Farm.**—We have called attention on several occasions to the activity which is being displayed in America and Germany with a view to utilising electrical power in farming operations. The application of electric power to the operation of farm machines such as cream separaters, churns, threshers, cutters, &c., involves no greater problem than the installation of any simple electric power plant. Practically the only difficulties attending its exploitation are such as long distance from an electric station or an absence of natural sources of power. A notable example of the application of electric power in farming is that at Ellerslie, which is about 90 miles north of New York. Here a former vice president, Mr. Levi P. Morton, has a model dairy farm, in which he has succeeded in demonstrating the utility and advantages of electricity in farming and dairy operations very completely. No expense has been spared in laying down a first-class electric installation, equipped with every appliance essential to the successful operation. The prime power is steam, which is generated on the premises, and the dynamos are supplemented by a storage battery plan which can be used directly for lighting in case of emergency. There are two boilers, namely, one of 80 H.P., which supplies all the steam ordinarily needed, whilst the second of 40 H.P. is used as a reserve and in cases of emergency. The electric plant consists of two C. and C. dynamos of 12·5 and 25 kilowatts respectively, belted directly to a straight line engine of 35 H.P. The smaller of the two dynamos operates at 500 volts, and is used for working the power circuit, whilst the larger, working at 110 volts, is used for charging the storage battery or in the lighting circuits in cases of emergency. On the lighting circuit there are nearly 300 lamps. The power circuit includes three motors, all of which are used for pumping water. All the buildings, sheds, dairies, &c., are lighted, of course, by means of electricity, and the equipment as a whole is thorough and unique. It is hoped that this installation will serve as a model for others who propose to use electricity on their farms. At any rate it completely demonstrates the possibility of applying electric power both efficiently and economically to the ordinary operations of the dairy farm.

**The Enclosed Arc Lamp.**—Mr. R. M. Hunter, of Philadelphia, writing in the *Electrical World*, says:—

> As the enclosed arc has taken a clearly defined position in the art of electric lighting of to-day, it is interesting to note the appreciation by scientists in the early days of commercial arc lighting of what we know to-day to be its essentials. The articles which have appeared in your paper by Mr. Marks are interesting, as showing the development of this improvement, and from these articles it is quite evident that the utility of the enclosed arc depends solely upon the capacity of the apparatus to slowly replace the effete products by air, the change being gradual, and capable only of maintaining life and clearness to the enclosed atmosphere in which the arc is maintained, without the rapid consumption, which is the result of unlimited quantities of air being supplied to the electrodes. This, then, is the secret of success of the enclosed arc, and while these features have been, by the articles referred to, accredited to recent date, they were, as a matter of fact, fully known, illustrated and described by Prof. Elihu Thomson in 1879, and also known to others at that time to be his invention. Among the evidence of this was a most complete specification for an application for letters patent prepared in February, 1879, in the handwriting of Prof. Edwin J. Houston, and signed by by both Profs. Thomson and Houston, which became evidence in an interference proceeding between Prof. Thomson and myself, upon the question of priority of invention of another matter. In this writing is described the advantage of excluding almost all fresh air from the enclosing globe, to reduce the consumption of the electrodes, and increase the longevity of the arc from a pair of carbons. Furthermore, means is shown and described to insure the very slow and gradual supply of air and escape of products of combustion so necessary to avoid blackening and bursting of the globe. In addition to this, the lamps are shown as arranged for constant potential circuits. While all this may be deemed as too ancient to be considered more than as historical, nevertheless it shows how possible it is for an inventor of the character of skill possessed by Prof. Thomson to foresee the necessities likely to arise in the future. This evidence, it seems to me, shows Prof. Thomson to be the first to devise and suggest the essentials for successful working of the enclosed arc.

**A Method of Treating Copper Slimes.**—In these days it would seem that it is the utilisation of hitherto unconsidered trifles which determine whether a manufacturing process shall pay or not, and lately some really wonderful processes of this kind have been devised. Copper slimes are more important than they would appear to be at first sight, for upon analysis it is found that they frequently contain a considerable quantity of metal. Thus in the electrolytic method of treating copper the slimes constitute about 4 per cent. of the total weight of the anode copper refined, and contain on an average from 15 to 30 per cent. of copper, besides such substances as silver, gold, arsenic, antimony, tellurium, &c. In the case of silver, the percentage may be as much as 50. An interesting method of refining the metallic constituents from their copper slimes is now being carried out at Baltimore. It is fully described in the *Engineering and Mining Journal*, Vol. 62 (22), page 512. This method is a wet one, and consists in treating the screened slimes in lead-lined vats with dilute sulphuric acid (1 to 3), through which air is injected for two or three hours. The solution, containing arsenic, copper, and most of the impurities, is siphoned from the residue, which contains lead sulphate, tellurium, a little bismuth and antimony, in conjunction with the silver and trace of gold. This residue is melted on a cupel hearth, at first without any flux, when a brownish slag containing lead and antimony, together with some silver prills, is skimmed off. The slag, after cooling, is picked over to separate the silver, and is then added to molten lead in the cupelling furnace, by which means the last traces of gold and silver are removed therefrom. The second stage of treating the slimes, after removing the brown slag, consists of heating with nitre, which extracts the tellurium. The silver metal on the cupel is now practically pure, with the exception of a little copper, and is cast into bars ready for parting in the usual way. The copper in the acid solution obtained by the first treatment is recovered by means of scrap iron. By combining this wet method of treating the copper slimes with the electrolytic method of refining copper, it would appear that the latter is made to show much greater profit.

**Mr. Wilde's Benevolence.**—Mr. H. Wilde, F.R.S., president of the Manchester Literary and Philosophical Society, whose generous donations to science we have already had the pleasure of recording, has now presented to the French Académie de Science the sum of five thousand five hundred pounds to be invested in French Rentes. The interest, amounting to about four thousand francs, is to be awarded annually as a prize to the author of the work on Astronomy, Physics, Chemistry, Mineralogy, Geology, or Mechanics which may be regarded by the Académie as the most deserving. Mr. Wilde makes this donation in recognition of the advantages he has derived from French science.

**Borough Electrical Engineers' Salaries.**—It is with considerable satisfaction that we record from time to time the liberal recognition afforded by some of our municipal electric lighting committees to their borough electrical engineers. That such recognition should be given is only right and proper, and a committee will, in the long run, find it worth while to pay a good salary to a first class man. With the success of municipal installations the excessive caution, or even niggardliness in this salary question, is giving way to a more reasonable and liberal spirit, though there are yet many places where there is room for great alteration. Bradford installation was one of the earliest in the country, and the name of the present borough electrical engineer (Mr. A. H. Gibbings) is familiar to all electric lighting men. It will be remembered that Mr. Gibbings left Hull for Bradford in 1895, the salary being £300. It will also be remembered that the Hull people offered Mr. Gibbings £300 to remain there, but the offer came too late in the day, as Mr. Gibbings had given his word to the Bradford Corporation, and could not honourably withdraw had he so desired. In view of these facts, it is interesting to note that the Bradford Gas and Electricity Committee recommends an increase in the engineer's salary from £300 to £500 per annum. With various electric lighting extensions in hand, and electric tramways in prospect, Mr. Gibbings has a busy time before him, and we hope the Council will unanimously agree to the Committee's recommendation.

**Tests of a Boese Accumulator.**—A few months ago a series of tests were made by the Central Naval Laboratory on an accumulator of the Boese type, comprising two elements hermetically sealed in celluloid boxes, protected by a wooden case. Each element consisted of three positive and four negative plates, their total weight being 4 kg. per element. The experiments, which were commenced at the end of July, 1896, were made with the object of testing their solidity as much from a mechanical as an electrical point of view. The apparatus has travelled constantly by road between Paris and Sevran-Livry; it has been subjected each week to prolonged charges and discharges at the maximum *régime* (10 amperes); on two different occasions it was left for eight days after being completely discharged and placed on short-circuit, in order to provoke the sulphating of the plates. The tests, which are still going on, do not as yet show any damage. The measurements of capacity taken in October, 1896, gave the following results:—

| Rate of discharging current. | Number of ampere-hours obtained. | Capacity per kilogramme of plates. |
|---|---|---|
| 3 amperes | 75 ampere-hours | 18·7 ampere-hours |
| 5 „ | 68 „ | 17 „ |
| 10 „ (maximum given by the maker) | 56 „ | 14 „ |
| 18 amperes | 50 „ | 12·2 „ |

**Minet's Aluminium Process.**—French metallurgists have always exhibited an interest in aluminium, and much of our knowledge on the subject is due to their researches. It has been estimated that at the present time fully 20,000 horse-power is daily used in the production of this metal in France. At St. Michel, in Savoy, some experiments have recently been carried out with various processes, but more especially with Minet's process of producing aluminium, and these are described in the *Revue de Physique et de Chimie*, Vol. 1, pages 55 to 62. At St. Michel, a mixture of 70 per cent. of sodium chloride, and 30 per cent. of a natural or chemically-prepared cryolite, is used in the bath. Bauxite and aluminium fluoride are fed into it, as the electrolytic process continues; 80 kilos. of this mixture are used as a charge, its melting point is 675° C.; 40 H.P. hours are required to produce 1 kilo of aluminium. The current efficiency is 70 per cent; the voltage 7·5, of which only 3 volts are actually used in separating the aluminium. A secondary reaction, due to the free hydrofluoric acid and the deposited aluminium, has been said to absorb 25 per cent. of the current; experiments with Heroult's process at Froges do not confirm this. The difference of potential observed at the terminals of the bath varies with the nature of the electrodes. With electrodes of copper, platinum, and carbon it is *nil;* whilst between carbon and molten aluminium it is at a maximum. It also varies proportionately with the current intensity. $E = 3{\cdot}1\ i$ for a current density below 10 amperes per square foot. Above this limit it can be calculated from $E = e + r\,i$, where $e$ = voltage required to decompose the aluminium salt, and $r$ = the resistance of the electrolyte; $e$ = 3 volts at 800° C., and = 2 volts at 1,100° C.; $r$ is about 0·00125 ohm; $e$ and $r$ have been experimentally proved constant for currents between 1,000 — 4,000 amperes.

**Electrical Figures of Philadelphia.**—In his annual report on the work of the Philadelphia Electrical Bureau, Chief Walker gives, says the N.Y. *Electrical Engineer*, some interesting figures. This city, with 129 square miles, is equipped with 885 fire boxes, 56 of which are in-doors, paid for by private individuals. New York, with but 31 square miles, has 2,500, and Chicago between 2,500 and 3,000. To thoroughly equip the city they should have at least 2,500 signal stations. The average price per arc lamp per night for 1895 was 41.15 cents; for 1896, 35.05, and proposals for 1897 show 33.3 cents, a reduction of $42,862.25. While the number 6,228 now provided for seems to be large, yet, when the great number of streets yet to be lighted is considered, it becomes insignificant. During the year there have been laid 221,834 feet of conduit by the city.

**The late Mr. Crossley.**—Among our successful manufacturers connected with the engineering business there have long been many men who have generously devoted a large share of their wealth to the assistance of their less fortunate brethren. In the list of these large-hearted benefactors the name of Mr. Frank William Crossley, of Messrs. Crossley Bros., Limited, whose death we briefly recorded last week, will long stand prominently. Like so many of our leading men who have risen from small beginnings, he was once an apprentice on the Tyne, from whence he proceeded to the drawing department of a Liverpool firm. Later he entered into the cotton manufacturing and India-rubber machinery, and being joined by his brother, W. J. Crossley, purchased the business and carried it on as Crossley Bros., at Manchester. The manufacture of gas engines was the branch in which we knew his name best, and the steps which led to the Crossleys taking up such work are stated by the *Engineer* of last week as follows:—

> Dr. Otto, of Deutz, near Cologne, being anxious to have his atmospheric gas engine manufactured in England, entered into negotiations with the firm of Crossley Bros., with the result that in 1870 they took up the manufacture of Otto gas engines for England and British possessions. The engine was gradually improved and developed, and was made in various sizes up to 3 horse-power. These were probably the most economical engine ever made, and some of them are still at work. The first of them made by this firm was bought back a few years ago, and is carefully preserved in the works. In 1876 the firm took up the manufacture of Dr. Otto's cycle compression engine, and its great success is too well known to require more than a passing reference. Its success was in no small measure due to Mr. Crossley's skill and talent as a designer, and its graceful lines have been much commented on. The business of Crossley Bros. was turned into a limited liability company in 1881, and from then until the day of his death Mr. Crossley filled the post of senior director of the company.

His philanthropy was of a practical kind, as he lived in the very heart of the worst quarters of Manchester, in order to be in touch with the people.

**Prize Competition for Electric Ploughs.**—The German Agricultural Society has arranged a prize competition for power-driven ploughs, intended more especially to encourage and develop the application of electrical power to the working of ploughs and other agricultural implements, says a German contemporary. The Society considers that, for many reasons, the application of electricity to agricultural driving promises considerable success, especially on account of the facility which electricity offers for transmitting power to considerable distances. In the trials which will be made by the society, non-electrical ploughs will also be tested, so that a comparison may be made of the relative efficiency of the different systems The tests will be made with ploughs only, since it is considered that only small alterations will be required to apply the power to other implements. Special attention will be attached to the conveyance of the arrangements from field to field. A first prize of 3,000 marks, and a second prize of 1,000 marks, will be given for the best plough driven by any kind of power, and a special prize for the best electrically-driven plough. At the trial, a piece of heavy and a piece of light land will be assigned to each plough, and the following points, says the N.Y. *Electrical Engineer*, will be noted:—1. The time taken for the ploughing; 2. The weight of earth moved; 3. The consumption of fuel by the motor; 4. The power consumed between the motor and the plough; 5. The cost of the ploughing, including fuel, water, lubricants, attendance, repairs, interest, and depreciation.

**Electric Meters.**—The report of the Committee of the Royal Scottish Society of Arts, appointed to judge electric meters submitted in competition for the special Keith prize of £50, was read at the meeting of the Society on 29th ult. The report states that nine meters were sent in, and they were tested at the Edinburgh Central station with the continuous and alternating current. The merits and demerits of the various meters were mentioned, and the Committee came to the conclusion that while several of the meters possessed many points of novelty and ingenuity which might be capable of further development, none of them were of sufficient merit to warrant the Society in making any award.

**Lord Rayleigh's Fifth Lecture.**—At the Royal Institution on Saturday afternoon, in the fifth lecture of his course on "Electricity and Electrical Vibrations," Lord Rayleigh continued, says the *Times*, the discussion of currents of very high frequency, and began by considering the means by which the rate of oscillation might be ascertained. In many cases an *a priori* calculation was the only available method, in other cases direct observation, by means of a rapidly revolving mirror, was practicable for the lower grades of frequency, and in spite of great difficulties had in combination with a photographic plate even been applied to the investigation of frequencies up to one million a second. In such cases the mirror must rotate at a very high speed. One device the lecturer showed consisted of a light piece of polished steel suspended between the poles of an electromagnet excited by an alternating current. Once this steel mirror was started, it would continue to rotate in step with the alternations of the current, the frequency of which governed the speed. Much the same principle was applied to secure an absolutely steady rotation by means of an intermittent current obtained with a tuning-fork, the speed of rotation following the regularity of the fork. One disadvantage of this device was that on account of difficulties with mercury contacts only weak currents could be employed, and therefore only light apparatus could be driven. The method, however, could be modified so that the bulk of the motive power was obtained from some other source, the electric current being used to put, as it were, the finishing touch to the steadiness of rotation. This action was not the same as that of the governor of a steam engine. In an ordinary engine the valves controlling the admission of steam were governed by its own revolution, but if they could be imagined to be controlled by something independent of the engine, the state of things would be more like what he had been speaking of. The remainder of the lecture was occupied with a number of experiments illustrating the behaviour of these high-frequency currents towards resistances of various kinds. One of the most interesting experiments was one performed by Hertz to show the influence of ultra-violet light on the resistance of air. Sparks passed freely at a particular spark-gap, so long as the light of another spark was allowed to fall on it through a quartz lens, but they ceased almost entirely when the ultra-violet light was cut off by means of the interposition of a piece of glass. Another striking and beautiful experiment exhibited the electrodeless discharge, obtained by placing an exhausted globe inside an electrified ring. Instead of the ordinary luminous phenomena showing characteristic differences at the anode and cathode, there was a uniform ring discharge without beginning or end.

**The Royal Society.**—Before this Society yesterday afternoon, the following papers were down for reading:—"The Production of X Rays of different Penetrative Values," by A. A. C. Swinton; "Cathode and Lenard Rays," by J. A. McClelland.

**Electrical Work in China and Japan.**—A Correspondent writes:—Li Hung Chang, or Chung Tang as he ought, we are informed, to be more properly named, will probably not thank the *Electrical Engineer*, of New York, for the advice given to its readers. They are to write to China's G.O.M., then bring all the out-of-works, those ambitious of making a fortune in China, and others, and ask him how to do it. It is as though every Kaiser-ridden Brandenburger, who wanted to shirk his fatherland of liberty, were to write to Lord Salisbury for the rates of an apartment in Bedford Place, and any assistance he could also render in selling German lamps to the electric light companies here. We don't envy his interpreter or secretary, who is "sure to attend to the matter." Our contemporary, however, while giving this advice, warns its readers against the chances of present business either in China or Japan. Indeed, the present commercial policy of Japan seems to be based on the same false ideas which dominate American finance—to wit, the exclusion of every possible outside influence. Li, if once reached at Tientsin, is, we are informed, easily accessible, and willing to listen and entertain suggestions. Altogether, this is a funny and amusing article, of decided spread-eagle complexion. It was not intended to be "wrote funny," which makes it all the more so.

**Electricity for Hospital Lighting.**—The Crewe Town Council had a discussion the other day regarding a proposal to have the new isolation hospital lighted electrically. An important statement was submitted by the medical officer, who calculated that if the hospital was lighted electrically 40 beds could be provided, whereas if lighted by gas only 28 beds could be used. The ex-Mayor stated that the difference in cost between electric lighting and gas was only a few pounds a year, whereas for cleanliness and health electric lighting was much more desirable. The Local Government Board had stated that as the gas pipes were already laid, the proposal for electricity would involve unnecessary expenditure. The motion for electric lighting was defeated by 13 votes to 10.

**A Curious Charge.**—At the South Western Police Court, the County of London and Brush Electrical Engineering Company were summoned by the Battersea Vestry for opening and breaking up the pavement in Trinity Road, Battersea. Mr. W. W. Young, who supported the summons, said the company had provisional orders to light with electricity the parishes of the Wandsworth District Board of Works. The vestry also had an order under which they proposed to light the parish. The company wished to make a short cut from Wandsworth to Clapham, and on a Sunday night, in September last, they surreptitiously opened the roads and laid their mains. The vestry found it out, and made them take them up. Again, in October, they surreptitiously opened the road, also on a Sunday night, and put down a pipe through which it was alleged wires were put to draw through the defendant's cable. The work was not finished until the morning, and in this way it was discovered. The contention was that the work was not carried out by this company, but by another. An official of the company was called into the witness box, and proved that the work was not executed by them. Mr. Young: Will you say who did? Witness declined to answer the question, and the summons was withdrawn.

**Lectures.**—On 29th ult. a lecture was delivered by Prof. Barrett, F.R.S.E., in the theatre of the Royal College of Science, Dublin, on "Dynamos and Motors."

In connection with the Literary and Philosophic Club, Clifton, a lecture was given on the 2nd inst. by the Very Rev. the Dean of Bristol, on "The Phenomena of Electricity." The lecture was illustrated by means of lantern slides.

Under the auspices of the Insurance Institute of Newcastle last week Mr. F. Broadbent, Assoc. Inst. E.E., M. (N.E. Coast) Inst. E. & S., superintending electrical engineer to Messrs. J. H. Holmes & Co., delivered a lecture on "Electricity" in the lecture theatre of the Newcastle Literary and Philosophical Society. Mr. Broadbent will give a continuation lecture on April 23rd.

**Chemical Meters Displaced by Mechanical Meters.**—An American exchange says that the Edison Electric Illuminating Company, of New York City, is installing in a large number of new service connections, and also substituting for many of the old chemical meters the Thomson mechanical wattmeters. This meter, as most of our readers know, is practically a small motor, whose armature is connected across the line and field coil in series therewith. The principal reason for this change is stated to be the fact that many of the customers of the company prefer a meter in which they can see the wheels go round. It would also appear that a decreased cost of operating the meter department would result.

**Metallic Solutions.**—At the Royal Institution, on Friday night, Mr. C. T. Heycock, F.R.S., gave a lecture on "Metallic Alloys and the Theory of Solution." After a reference to the experiments of Matthiessen, Chatelier, Roberts-Austen, and Dewar and Fleming, he showed a number of experiments which established an analogy between the solution of a substance such as sugar in water and the solution of metals in each other. Just as the freezing point of a solution of a salt in water was lower than that of pure water, so the freezing point of a solution of a metal, such as thallium, in mercury, was lower than that of pure mercury.

**Royal Institution.**—The following are among the lecture arrangements after Easter:—Prof. Dewar, three lectures on "Liquid Air as an Agent of Research." The Friday evening meetings will be resumed on April 30th, when a discourse will be given by Prof. J. J. Thomson on "Cathode Rays;" succeeding discourses will probably be given by the Right Hon. Lord Kelvin, Prof. H. Moissan, Mr. W. H. Preece, Mr. William Crookes, and other gentlemen.

**Vacant Appointment.**—A telegraph clerk is wanted for the Government Telegraph Department, Gold Coast, at a salary of £200, with free quarters. See our "Official Notices."

**Accident.**—A Belfast man, employed by Messrs. Harland and Wolff, Limited, was admitted to the Royal Hospital on 30th ult., suffering from concussion and scalp wounds, caused by an electric light wire falling on him.

**The Institution Secretaryship.**—The secretaryship of the Institution of Electrical Engineers will early next year be vacated upon the resignation of Mr. F. H. Webb, after a very lengthy period of service. The Council are therefore prepared to receive applications for the appointment, and particulars of the necessary qualifications will be obtained from our "Official Notices." The salary is £400 per annum. April 30th is the latest date for sending in applications.

**Approaching Marriage.**—A marriage has been arranged, and will take place in June, between Mr. John Verity, J.P., of Aston, Warwickshire, and Sandridge Bury, Hertforshire, and Evelyn Mary, eldest daughter of Mr. Henry Lubbock, D.L., of Lombard Street, and of Newberries, Hertfordshire. Mr. John Verity is chairman of Veritys Limited, and is well known in the electrical world, while Miss Lubbock is a niece of Sir John Lubbock, Bart.

**The Institution of Junior Engineers.**—On Tuesday, April 13th, 8 p.m., at the Westminster Palace Hotel, Lecture VI. of the special course on "Dynamo Design, Construction and Working," will be delivered by Mr. F. A. Nixon.

**Death of Dr. Von Stephan.**—Dr. Heinrich von Stephan, Secretary of State for the German Imperial Post Office, passed quietly away at half-past twelve o'clock on Thursday morning. He was born January 7th, 1831. It was due to him that in 1875 the postal and telegraph systems of Germany were united. Stephan's most important work, however, was the establishment of the Postal Union, to which, with few exceptions, all civilised States now adhere.

## NEW COMPANIES REGISTERED.

**Borough Mills Power Company, Limited** (51,901). Registered April 1st, with capital of £1,000 in £1 shares, to enter into a certain agreement, to rent or otherwise acquire, work, and turn to account the engines, boilers, dynamos, accumulators, &c., used on the Borough Mills Estate, Manchester Road, Bradford, and to produce and supply to the tenants of the said estate, and others, power, heat and light, by means of steam, heat and electricity. The subscribers (with one share each) are:—William Kemp, 37, Elizabeth Street, Horton, Bradford, brass founder; Albert J. Harris, 59, Silk Street, Manningham, Bradford, electrical engineer; Arthur Gledhill, 89, Grantham Road, Bradford, millwright; Albert Jowett, 101A, Gaythorne Road, Bradford, manufacturer; Thos. Nicholl, 17, Hampton Street, Bradford, wire polisher; Cecil Wray, 2, Southbrook Terrace, Bradford, electrician; Samuel Drake, 45, Victoria Street, Manningham, Bradford, wood turner. The first directors are W. Kemp, A. J. Harris, A. Gledhill, A. Jowett, T. Nicholl, C. Wray and S. Drake; qualification, 10 shares. Registered by Kelly & Co., 11 and 13, King Street, Westminster.

**Tinker, Shenton and Company, Limited** (51,933).—Registered April 2nd with capital £30,000, in £50 shares, to acquire the business carried on as Tinker, Shenton & Co., at Hyde, near Manchester, to enter into a certain agreement, and to carry on the business of mechanical and electrical engineers, machine and engineering tool makers, boiler makers, &c. The subscribers (with one share each) are: J. Shenton, Green Field House, Newton, Hyde, boiler maker; J. E. Shenton, 40, Throstle Bank Street, Hyde, boiler maker; B. Taylor, 55, Union Street, Hyde, cashier; R. Shenton, 34, Bennett Street, Hyde, boiler maker; W. Denton, 81, Bennett Street, Hyde, mechanic; C. Lote, Matley Hall, near Hyde, draughtsman; R. Shenton, 139, Ashton Road, Hyde, draughtsman. The number of directors is not to be less than three, nor more than nine; the first are the first three subscribers; qualification, £100; remuneration as the company may decide. Registered office, Hyde Boiler Works, Hyde, Cheshire.

**B. C. Electrical Syndicate, Limited** (51,952).—Registered April 3rd with capital £75,000 in £100 shares, to adopt an agreement with the Colonial Railway and General Investment Company, Limited, and to subscribe for £75,000 first income £6 per cent. mortgage bonds of the British Columbia Railway Company, Limited, ranking after £250,009 £4½ per cent. first mortgage debentures. The subscribers (with one share each) are:—R. M. H. Payne, 8, Austin Friars, E.C., stockbroker; C. W. P. Slade, 11, Chesham Place, S.W., gentleman; R. W. Garbutt, 8, Austin Friars, E.C., stockbroker; R. N. Laurie, 57, Sloane Gardens, S.W., merchant; R. K. Sperling, 8, Austin Friars, E.C., stockbroker; E. Welton, 8, Austin Friars, E.C., gentleman; E. A. Bennett, 67, Portsdown Road, Maida Vale, gentleman. The number of directors is not to be less than three nor more than five; the first are R. M. H. Payne, H. Payne, Q.C., A. C. Mitchell-Innes, R. N. Laurie, and R. K. Sperling; qualification £100; remuneration as fixed by the company. Registered office, 1 and 2, Great Winchester Street, E.C.

## CITY NOTES.

### Evered & Co, Limited.

The directors' report shows that, after providing for debenture interest, amounting to £2,416 13s. 4d., a net profit of ... ... ... ... ... ... £22,539 15 11

making, with £4,809 3s. 1d. brought forward from 1895, the sum of £27,348 19s. to be dealt with.

The directors propose—

| | | | |
|---|---|---|---|
| To pay a dividend of 10 per cent. for the year on the old capital, of which an interim dividend of 3¾ per cent. has been paid in September last ... | 13,570 | 8 | 0 |
| „ Pay a dividend at the rate of 10 per cent. per annum on the new capital for the time and amounts paid thereon ... ... ... ... | 1,490 | 0 | 0 |
| Absorbing ... ... ... | 15,060 | 8 | 0 |
| „ Place to an equalisation of dividends account ... | 5,000 | 0 | 0 |
| „ Carry forward to next account ... ... ... | 7,288 | 11 | 0 |
| | £27,348 | 19 | 0 |

| | | | |
|---|---|---|---|
| And with the balance of premium on shares ... ... ... ... ... | £16,523 | 7 | 10 |
| To place to the credit of building fund (making £5,000)... ... ... | 1,000 | 0 | 0 |
| „ Place to the credit of new fixtures, London account ... ... ... | 523 | 7 | 10 |
| „ Write off plant ... ... ... | 1,000 | 0 | 0 |
| „ „ goodwill (leaving £6,000) | 14,000 | 0 | 0 |
| | £16,523 | 7 | 10 |

To meet the requirements of a larger trade, the directors found it necessary to increase the working capital, and in June last the balance of the share capital was offered for public subscription at a premium, was largely over-applied for, and has been duly allotted. The building in London of new offices and warehouses has been completed, also new workshops and warehouses (necessitated by increased trade) at Smethwick and Birmingham have been erected, and are now in full working order. The business of the company continued to grow all through the year, and is at present well maintained. One of the directors, Mr. Ravenscroft, owing to advanced age, has resigned. The board has elected Mr. W. G. Kent, of 199, High Holborn, and Stanmore, a duly qualified shareholder to fill the vacancy, and asks your confirmation of same.

### The Bournemouth and District Electric Supply Company, Limited.

The report of the directors, to be presented to the shareholders at the sixth annual general meeting of the company, to be held at the registered offices, Verulam House, Yelverton Road, Bournemouth, on Tuesday, April 13th, 1897, at 2.30 p.m., states that the capital account shows an expenditure during that period of £7,780 9s. 10d., chiefly upon buildings, machinery and mains, the funds for which were obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account shows a total income of £8,243 12s. 1d. as against £7,431 3s. 10d. in the previous year, and the total costs amount to £5,960 5s. 8d. If, however, the following items of exceptional expenditure be deducted, viz, £326 1s. 9d. for repairs to condensing apparatus and £395 11s. 10d for replacement of meters, the total costs amount to £5,238 12s. 1d. as against £5,272 12s. 7d. in 1895. A sum of £400 16s., representing the difference between the cost price and the amount realised on sale of old plant, has been charged to suspense account. The net revenue account, after payment of interest charges on loans and debentures, shows a debit balance of £928 10s. 9d, which has been carried to general balance-sheet. The connections to the company's mains on December 31st last were equivalent to 23,203 8-C.P. lamps; the increase for the year being equivalent to 2,636 8-C.P. lamps. Notwithstanding the increased sale of 38,000 units, the fuel costs have been reduced by £204 6s. 7d., as compared with the previous year. Application has been made to the Board of Trade for a provisional order for the districts of Poole and Branksome, and the local authorities concerned have given their consents. The present plant capacity of the station will probably prove sufficient to meet the increased demand for current which may be anticipated from the extended area

of supply for the next few years, and it is expected that in the near future additional capital expenditure will only be required for mains and meters on consumers' premises. The retiring director is Mr. R. Percy Sellon, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election.

## Willans and Robinson, Limited.

The sixth half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at 3 p.m. on Wednesday, April 14th, 1897, states that after writing off as depreciation from plant, patents, &c., the sum of £4,623 12s. 10d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £489 17s. 2d. brought forward) is £14,320 7s. 6d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum, as before, upon the ordinary shares, together amounting to £7,312 10s. The amount payable to the directors, in accordance with the articles of association, is £1,955 8s., leaving a balance of £5,052 9s. 6d. Out of this the directors propose to carry £2,000 to a debenture redemption fund, and £1,000 to the reserve fund, leaving a balance of £2,052 9s. 6d. to be carried forward. In accordance with the resolution passed at the general meeting held last October, the expenses connected with the issue of debenture stock, amounting to £1,151 8s. 2d., were written off from the balance carried forward at the end of June, 1896, reducing the amount to £489 17s. 2d., as stated above. The issue of 4,500 preference shares of £5 each, at a premium of £1, and of 4,500 ordinary shares of £5 each, at a premium of £2, has been successfully carried out in accordance with the resolution passed at the extraordinary general meeting held on February 2nd, 1897. The applications from existing shareholders greatly exceeded the number of shares disposable. The registered office of the company was transferred from Thames Ditton to Rugby on March 18th, the transfer of tools and stores having been in progress for some time previously. A serious interruption of work is inevitable under the circumstances, but every effort has been made to minimise it. In accordance with the provisions of the articles of association, applicable to the present occasion, all the directors retire, but offer themselves for re-election. At the extraordinary general meeting held in February last, an opinion was expressed in favour of an addition to the board. On the ground that they believe this opinion to be widely approved amongst the shareholders, the directors advise that the number of directors be increased from three to five, and they recommend the names of Lieutenant-General Sir Richard Hieran Sankey, K.C.B., late chairman of the Irish Board of Works, and of Mr. Thomas Orger Lazenby, as those of suitable persons for election as directors. Both gentlemen have wide business experience; both are largely interested in the company, and both were shareholders in the company which preceded the present one. Sir Richard Sankey holds 1,338, and Mr. Lazenby 1,190 shares. Should additional directors be elected, it will be necessary to settle their remuneration, and it is suggested that a fee of £500 per annum for the two directors, to be divided between them as they may arrange, would be a suitable remuneration. The auditors, Messrs. Cooper Brothers & Co., retire, but are eligible for re-election.

## British Insulated Wire Company, Limited.

This company held its sixth ordinary general meeting last week at the offices, Prescot. The directors present were Messrs. W. Marriner Brigg (chairman), J. B. Atherton, S. Z. de Ferranti, E. K. Muspratt, J.P., J. E. Pearson, and T. Snape, J.P., and Mr. Edward Tracey (secretary). The directors, in submitting accounts for the year ending December 31st last reported that the result of the year's working showed a profit of £46,123 15s. 3d. After deducting administration expenses, interest on debentures, dividend on the preference shares, making provision for bad and doubtful debts, legal and other expenses, there remained a balance of £34,889 3s. 9d. It was unanimously resolved that a dividend of 10 per cent. be paid forthwith on the ordinary A and B shares, leaving the sum of £27,115 19s. 7d., of which it was resolved a sum of £20,415 8s. 3d. be placed to a reserve account to meet depreciation on buildings, plant, &c., and writing off patents account the sum of £3,700 11s. 4d., thus leaving a balance of £3,000 to be divided equally between the founders' and the ordinary A and B shares in accordance with the memorandum and articles of association. Messrs. J. B. Atherton and E. K. Muspratt were re-elected directors. Messrs. Chalmers, Wade, & Co., of Liverpool, were re-appointed auditors.

## British Aluminium Company, Limited.

The meeting of this company was held at the Westminster Palace Hotel yesterday, Mr. R. W. Wallace, Q.C., presiding.

The Chairman, in moving the adoption of the report, pointed out that in every new enterprise of this kind there were certain difficulties, apart from the construction of the works, in starting the plant. Men had to be trained in localities where they had not been used to manufacturing work of any kind. They had to be educated to the art that this company was endeavouring to develop. This had been accomplished very satisfactorily. They had been working practically since last September, and in the first few months it was impossible to produce the product at the cheapest price while training the men. But owing to this company's alliance with other similar companies those expenses had been very small. They had had the benefit of the large amount of capital which had been spent in Neuhausen and in France in developing the aluminium industry. Regarding the accounts, the first 150,000 preference shares were fully subscribed, and at Dec. 31st only £2 was in arrear, and the new issue was all paid up but £954. They had a very large freehold property of more than 12 square miles at Foyers, and these were mortgaged at 3½ and 4½ per cent., and the directors preferred them in that form rather than in debenture issues. The reserve fund (£3,750) was invested in the Acetylene Illuminating Company. After deducting the interest on mortgages and other charges, it was proposed to declare a first dividend on the 7 per cent. cumulative preference shares which were paid up at the end of 1895. Stocks (principally materials) on hand amounted to £18,534. The company made nearly all the raw material used, and that material required at the different factories a large amount of stock. The chairman referred to the farms, and also explained by means of maps the relative positions of the Foyers, Larne, and Staffordshire establishments, and how they were conveniently situated as regards communication by boat. They had been able at Larne to produce alumina extremely pure, with over 99 per cent. of pure alumina. It takes 2 tons of alumina to make 1 ton of aluminium at Foyers, the remainder being oxygen, which was driven off into the air. At Greenock they had had a factory finished for eight months for the production of electrolytical carbons, a large number of which had to be used for the anodes of the electrical furnaces. The demand for aluminium is increasing very rapidly. The company had no difficulty in disposing of its supplies. On the contrary they were afraid that the demand would be too great if provision was not made to cope with it at once. Therefore they were not proposing to reduce the price, though they could well do it. New plant, to cope with the demand was ordered, and would be erected in three or four months. The company had given its orders to Switzerland up to the present, because they had had more experience in respect to these particular dynamos, but in future they intended to place the orders in this country, if they could get them properly made, which he did not doubt they could. Taking bulk into consideration, the price of aluminium and copper was the same; copper was 3½ times the weight of aluminium. After referring to the valuable water power concessions the company has obtained, the means adopted for storage of water, Mr. Wallace stated that this company was able to produce aluminium cheaper than anybody else. The company had prosecuted its lawsuits to restrain the importation into this country from America, and they had now received a proposition with a view to terminating the litigation. The matter was not quite settled. He was in favour of avoiding the expense of litigation if possible. They had been considering a proposal that they should supply from the Larne factory alumina for the Neuhausen Company. Such an arrangement would cheapen the production for both companies by the larger yield, and a reduction of the establishment charges. They had been able to make a small profit, and probably next year they would have a substantial one. For the purpose of the orders given out, they would create second 5½ per cent. debentures, and the directors had taken up £30,000, and the remaining £20,000 would be open to the shareholders.

Mr. A. S. Bolton, J.P., seconded the motion, and it was carried.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman and directors closed the meeting.

## The Cambridge Electric Supply Company, Limited.

Revenue Return for March Quarter.

| | | |
|---|---|---|
| Number of units sold, 1897 | ... ... ... ... | 76,382 |
| " " 1896 | ... ... ... ... | 65,425 |
| | 1897. | 1896. |
| Revenue from electricity supply | £2,070 3 0 | £1,767 10 9 |
| " " meter rents, &c. | 67 15 5 | 60 19 1 |
| | £2,137 18 5 | £1,828 9 10 |

**Anglo-American Telegraph Company, Limited.**—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1897, of 12s. 6d. per cent. on the ordinary stock and £1 5s. per cent. on the preferred stock, less income-tax, payable on May 1st, to the stock-holders registered on the books of the company on March 31st, 1897.

**New Fowler-Lancaster, Limited.**—Under the title of New Fowler-Lancaster, Limited, and with a capital of £100,000, in £1 shares, of which the present issue is 75,000 shares, a company has been formed to acquire, as a going concern, the business, property and assets generally of Fowler, Lancaster & Co., Limited, of Birmingham, electrical and mechanical engineers, cycle component manufacturers, auto-car builders, &c. The subscription list opened on Monday, and closed on Wednesday.

## TRAFFIC RECEIPTS.

**The City and South London Railway Company.** The receipts for the week ending April 4th, 1897, were £1,026; week ending April 5th (Good Friday), 1896, £815; increase, £211; total receipts for half-year, 1897, £14,818; corresponding period, 1896, £13,471; increase, £1,347.

The Great Northern Telegraph Company. The receipts in March, 1897, were £22,800; January 1st to March 31st 1897, £65,200; corresponding month, 1896, £66,800; corresponding month, 1895, £68,000.

**The Liverpool Overhead Railway Company.** The receipts for the week ending April 4th, 1897, amounted to £1,323; corresponding week last year, £1,256; increase, £67.

**The Western and Brazilian Telegraph Company, Limited.** The receipts for the week ending April 2nd, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,234.

# SHARE LIST OF ELECTRICAL COMPANIES.

## TELEGRAPH AND TELEPHONE COMPANIES.

| Present issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1894. | 1895. | 1896. | Closing Quotation, March 31st. | Closing Quotation, April 7th. | Business done during week ended April 7th, 1897. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 175,400£ | African Direct Teleg., Ltd., 4 % Deb. ... ... ... | 100 | 4 % | 4 % | ... | 100 —104 | 100 —104 | ... | ... |
| 25,000 | Amazon Telegraph, Limited, shares... ... ... ... | 10 | ... | ... | ... | 4½— 5½ | 4½— 5½ | ... | ... |
| 1,912,880£ | Anglo-American Teleg., Ltd. ... ... ... ... ... | Stock | £2 2s. | £2 9s. | £2 13s. | 50 — 56 | 50 — 53 | ... | ... |
| 2,993,560£ | Do. do. 6 % Pref. ... ... ... ... ... | Stock | £4 4s. | £4 18s. | £5 6s. | 94½— 95½ | 95 — 96 | 95⅝ | 94⅜ |
| 2,993,560£ | Do. do. Defd. ... ... ... ... ... ... | Stock | ... | ... | ... | 8 — 8½ | 8 — 8½ | 8½ | 8 7/16 |
| 139,660 | Brazilian Submarine Teleg., Ltd. ... ... ... ... | 10 | 7 % | 7 % | ... | 15 — 15½ | 15 — 15½ | 15 5/16 | 15 |
| 75,000£ | Do. do. 5 %, Debs., 2nd series, 1906 ... ... | 100 | 5 % | 5 % | ... | 113 —117 | 113 —117 | ... | ... |
| 44,000 | Chili Telep., Ltd., Nos. 1 to 44,000 ... ... ... | 5 | 2½% | 4 % | ... | 3½— 3⅝ | 3½— 3⅝ | ... | ... |
| 19,660,000$ | Commercial Cable Co. ... ... ... ... ... | $100 | 7 % | 7 % | 7 % | 162 —167 | 162 —167 | ... | ... |
| 224,850 | Consolidated Telep. Const. and Main., Ltd. ... ... | 10/- | 1½% | 1½% | ... | 1/16— 3/16 | 1/16— 3/16 | ... | ... |
| 16,000 | Cuba Teleg., Ltd. ... ... ... ... ... ... | 10 | 8 % | 8 % | 8 % | 10 — 11 | 10 — 11 | 10½ | 10 |
| 6,000 | Do. 10 % Pref. ... ... ... ... ... | 10 | 10 % | 10 % | 10 % | 19 — 20 | 19 — 20 | 19 | ... |
| 12,231 | Direct Spanish Teleg., Ltd. ... ... ... ... ... | 5 | 4 % | 4 % | 4 % | 3½— 4½ | 3½— 4½ | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. ... ... ... | 5 | 10 % | 10 % | 10 % | 10 — 10½ | 10 — 10½ | ... | ... |
| 30,000£ | Do. do. 4½ % Debs. Nos. 1 to 6,000 ... | 50 | 4½% | 4½% | 4½% | 105 —108 % | 105 —108% | 105½ | ... |
| 60,710 | Direct United States Cable, Ltd. ... ... ... ... | 20 | 2 % | 2½% | 2½% | 8⅜— 9½ | 8⅜— 9½ | 9⅜ | 9 |
| 400,000 | Eastern Teleg., Ltd., Nos. 1 to 400,000 ... ... | 10 | 6½% | 6½% | ... | 17 — 17½ | 17 — 17½ | 17⅜ | 17 |
| 70,000 | Do. 6 % Cum. Pref. ... ... ... ... | 10 | 6 % | 6 | ... | 18 — 19 | 18 — 19 | ... | ... |
| 102,100£ | Do. 5 % Debs., repay. August, 1899 ... ... | 100 | 5 % | 5 % | ... | 103 —106 | 103 —105 | ... | ... |
| 1,297,837£ | Do. 4 % Mort. Deb. Stock Red. ... ... | Stock | 4 % | 4 % | ... | 127 —130 | 127 —130 | 128⅜ | ... |
| 250,000 | Eastern Extension, Australasia and China Teleg., Ltd. ... | 10 | 7 % | 7 % | % | 17⅝— 18¼ | 17⅝— 18¼ | 18 3/16 | 17⅞ |
| 54,100£ | Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 | 100 | 5 % | 5 % | 5% | 100 — 104 | 100 —104 | ... | ... |
| 194,300£ | Do. do. Bearer, 1,050—3,975 and 4,327—6,400 | 100 | 5 % | 5 % | 5% | 101 —104 | 101 —104 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock ... ... ... ... ... | Stock | 4 % | 4 % | 4% | 127 —130 | 127 —130 | 127 | ... |
| 80,600£ | Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | 5 % | 5% | 100 —104 | 100 —104 | 100 | ... |
| 107,600£ | Do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | 5 % | 5% | 101 —104 | 101 —104 | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909 | 100 | 4 % | 4 % | 4% | 107 —110 | 107 —110 | ... | ... |
| 200,600£ | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | 4 % | 4 % | 4% | 109 —112 % | 109 —112 % | 109½ | ... |
| 180,227 | Globe Telegraph and Trust, Ltd. ... ... ... | 10 | 4½% | 4½% | ... | 11 — 11½ | 11 — 11½ | 11⅜ | 11 3/16 |
| 180,042 | Do. do. 6 % Pref. ... ... ... | 10 | 6 % | 6 % | ... | 17 — 17½ | 17 — 17½ | 17 5/16 | 17 |
| 150,000 | Great Northern Teleg. Company of Copenhagen ... ... | 10 | 8⅝% | 10 % | ... | 24 — 25 | 24 — 25 | 25 | 24 9/16 |
| 180,000£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | ... | 102 —105 | 102 —105 | ... | ... |
| 17,000 | Indo-European Teleg., Ltd. ... ... ... ... ... | 25 | 10 % | 10 % | ... | 55 — 58 | 55 — 58 | ... | ... |
| 100,000£ | London Platino-Brasilian Teleg., Ltd. 6 % Debs. ... ... | 100 | 6 % | 6 % | 6% | 107 —110 | 107 —110 | ... | ... |
| 28,000 | Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ... | 5 | 4 % | 4 % | ... | 2 — 2½ | 2 — 2½ | ... | ... |
| 484,597 | National Teleph., Ltd., 1 to 484,597 ... ... ... | 5 | 5 % | 5½% | 5½% | 6⅞— 7⅛ | 6½— 6½ | 7 | 6½ |
| 15,000 | Do. 6 % Cum. 1st Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 16 — 18 | 15 — 17 | 16½ | 16 |
| 15,000 | Do. 6 % Cum. 2nd Pref. ... ... | 10 | 6 % | 6 % | 6 % | 16 — 18 | 16 — 18 | 16½ | 15⅝ |
| 119,234 | Do. 5 % Non-cum. 3rd Pref., 1 to 119,234 | 5 | 5 % | 5 % | 5 % | 6 — 6½ | 6 — 6½ | 6 3/16 | 6 |
| 1,100,000£ | Do. 3½ % Deb. Stock Red. ... ... | Stock | 3½% | 3½% | 3½% | 102 —105 | 102 —105 | 103⅞ | 102 |
| 171,504 | Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid | 1 | 4¼% | 5 % | ... | ⅝— ¾ | ⅝— ¾ | ... | ... |
| 100,000£ | Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000 | 100 | 4 % | 4 % | 4% | 107 —110 | 107 —110 | ... | ... |
| 11,839 | Reuter's Ltd. ... ... ... ... ... ... ... | 8 | nil | 5 % | ... | 7 — 8 | 7 — 8 | ... | ... |
| 3,381 | Submarine Cables Trust ... ... ... ... ... | Cert. | ... | ... | ... | 138 —143 | 138 —143 | 138 | ... |
| 58,880 | United River Plate Teleph., Ltd. ... ... ... | 5 | 3 % | 4 % | ... | 3 — 3½ | 3 — 3½ | ... | ... |
| 146,723£ | Do. do. 5 % Debs. ... ... ... | Stock | 5 % | 5 % | ... | 100 —105 | 100 —105 | ... | ... |
| 15,509 | West African Teleg., Ltd., 7,501 to 23,109 ... ... ... | 10 | nil | 4 % | ... | 5 — 6 | 5 — 6 | ... | ... |
| 228,300£ | Do. do. do. 5 % Debs. ... ... ... | 100 | 5 % | 5 % | ... | 101 —104 | 101 —104 | 104 | ... |
| 36,636 | West Coast of America Teleg., Ltd. ... ... ... ... | 10 | nil | nil | ... | ⅜ — 1½ | ⅜ — 1½ | ... | ... |
| 150,000£ | Do. do. do. 8 % Debs., repay. 1902 | 100 | 8 % | 8 % | ... | 101 107 | 103 —108 | 104 | ... |
| 64,248 | Western and Brazilian Teleg., Ltd. ... ... ... ... | 15 | 3 % | 3 % | ... | 7⅜— 8¼ | 7⅜— 8¼ | 7 13/16 | ... |
| 33,129 | Do. do. do. 5 % Pref. Ord. ... | 7½ | 5 % | 5 % | ... | 6¼ — 6⅝ | 6¼ — 6⅝ | ... | ... |
| 33,129 | Do. do. do. Def. Ord. ... ... | 7½ | 1 % | 1 % | ... | 1⅝— 2¼ | 1⅝— 2¼ | 2 | 1⅞ |
| 155,200£ | Do. do. do. 6 % Debs. "A," 1880 Red. | 100 | 6 % | 6 % | ... | 112 —116 | 112 —116 | ... | ... |
| 206,400£ | Do. do. do. do "B," do. | 100 | 6 % | 6 % | ... | 109 —113 | 109 —113 | ... | ... |
| 88,321 | West India and Panama Teleg., Ltd. ... ... ... | 10 | 1¾% | 1¾% | ... | ⅞ — 1⅛ | ⅞ — 1⅛ | ... | ... |
| 34,563 | Do. do do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | ... | 11 — 11½ | 11 — 11½ | 11 7/16 | ... |
| 4,569 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | ... | 9½— 10½ | 9½— 10½ | 9⅝ | ... |
| 88,860£ | Do. do. 5 % Debs. No. 1 to 1,800 ... | 100 | 5 % | 5 % | ... | 107 —110 | 107 —110 | ... | ... |
| 1,777,000$ | Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ... | $1000 | 7 % | 7 % | 7% | 107 —112 | 107 —112 | ... | ... |
| 164,360£ | Do do 6 % Ster. Bonds ... | 100 | 6 % | 6 % | 6% | 100 —105 | 100 —105 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electy. Supply ... ... ... | 5 | 4½% | 5 % | 6 % | 10½— 11½ | 10½— 11½ | 10⅞ | 10 13/16 |
| 10,277 | *Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ... | 5 | 5 % | 5 % | 5 % | 9 — 9½ | 8⅞— 9½ | 9 5/16 | ... |
| 60,000 | Do. do. do. 4½ % Deb. Stock Red. ... | Stock | ... | 4½% | 4½% | 112 —115 | 112 —115 | ... | ... |
| 40,000 | City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000 | 10 | 5 % | 5 % | 7 % | 19½— 20½ | 19 — 20 | 19⅝ | 19½ |
| 40,000 | Do. do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 16½— 17½ | 16½ — 17½ | 17⅛ | 16⅝ |
| 360,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | 5 % | 132 —136 | 132 —136 | 132½ | 132 |
| 22,475 | County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475 | 10 | ... | nil | nil | 11½ — 12 | 11½ — 12 | 11⅝ | ... |
| 20,000 | Do. do. do. 6% Pref., 40,001—50,000 ... | 10 | ... | 6 % | 6 % | 14½— 15 | 14½— 15 | 15 | 14⅝ |
| 10,000 | Do. do. iss. at 2 pm., all paid ... | 10 | ... | ... | ... | 14½— 14⅝ | 14½— 14⅝ | 14⅝ | ... |
| 49,900 | *Metropolitan Electric Supply, Ltd., 101 to 50,000 ... | 10 | 3 % | 4 % | ... | 15½— 16½ | 15½— 16½ | 16⅛ | 15½ |
| 12,500 | Do. Ord., 50,001—62,500, iss. at £2 prem. ... | 10 | ... | ... | ... | 11½ — 12½ | 11½ — 12½ | 11⅝ | ... |
| 150,000£ | Do. 4½% first mortgage debenture stock ... ... | ... | 4½% | 4½% | ... | 120 —124 | 120 —124 | ... | ... |
| 6,452 | Notting Hill Electric Lightg. Co., Ltd. ... ... ... | 10 | 1 % | 2 % | 4 % | 12 — 13 | 11½— 12½ | 12½ | 12⅝ |
| 19,980 | *St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080 | 5 | 6½% | 7½% | 10½% | 14 — 15 | 14 — 15 | 14⅜ | 14½ |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 9½— 10½ | 9½— 10½ | 10⅛ | 9 13/16 |
| 50,000 | Do. do. 4 % Deb. stock Red. ... | Stock | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 67,200 | *Westminster Electric Supply Corp., Ord., 101 to 60,000 ... | 5 | 5 % | 7 % | 9 % | 13 — 14 | 13½— 14½ | 13⅝ | 13½ |

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. | | | Closing Quotation March 31st. | Closing Quotation, April 7th. | Business done during week ended April 7th, 1897. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1894. | 1895. | 1896 | | | Highest. | Lowest. |
| 90,000 | Brush Elecl. Enging. Co., Ord., 1 to 90,000... ... ... | S | 2½% | ... | ... | ¾ — 1 | ¾ — 1 | ⅞ | 13/16 |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 3 % | ... | ... | 1½ — 1½ | 1½ — 1½ | 1½ | 1 3/16 |
| 125,000£ | Do. do. 4½ % Perp. Deb. Stock.... ... | Stock | 4½% | ... | ... | 104 —108 | 104 —108 | ... | ... |
| 76,770 | Do. do. 4½% 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 95 — 99 | 95 — 99 | ... | ... |
| 9,104 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 9½ — 10 | 9½ — 10 | ... | ... |
| 207,649 | Do. do. do. £6 paid ... ... | 10 | ... | ... | ... | 5½ — 6 | 5½ — 6 | ... | ... |
| 630,000£ | City and South London Railway ... ... ... ... | Stock | 1½% | 1 2/16% | 1 9/16% | 59 — 61 | 59 — 61 | 60⅜ | 60 |
| 28,180 | Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180 | 5 | *nil* | *nil* | ... | 1¾ — 2¼ | 1¾ — 2¼ | ... | ... |
| 89,261 | Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261 | 5 | 5 % | 5 % | ... | 1⅞ — 2¼ | 1⅞ — 2¼ | ... | ... |
| 17,139 | Do. do. do. "A" Shares 01—017,139 | 5 | 5 % | 5 % | ... | 3 — 4 | 3 — 4 | 3⅜ | 2 15/16 |
| 100,000 | Do. do. do. 4½% Deb. Stock Red. ... | Stock | 4½% | 4½% | ... | 105 —110 | 106 —110 | ... | ... |
| 110,000 | Electric Construction, Ltd., 1 to 110,000 ... ... ... | 2 | *nil* | 5 % | ... | 1½ — 1⅝ | 1½ — 1⅝ | 1⅝ | ... |
| 12,845 | Do. do. 7 % Cum. Pref., 1 to 12,845 ... | 2 | 7 % | 7 % | ... | 3¼ — 3¼ | 2⅜ — 3¼ | ... | ... |
| 91,195 | Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000 ... ... | 2 | *nil* | ... | ... | ¼ — 1½ | ¼ — 1½ | 1 | ⅞ |
| 69,385 | Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ... | 2 | *nil* | ... | ... | ⅜ — ⅝ | ⅜ — ⅝ | ... | .. |
| 9,600£ | Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ... | 10 | *nil* | 10½% | .. | 12 — 14 | 12 — 14 | ... | ... |
| 10,000 | Henley's (W. T.) Telegraph Works, Ltd., Ord. ... ... | 10 | 6 % | 8 % | 10 % | 19½ — 20½ | 19 — 20 | ... | ... |
| 3,000 | Do. do. do. 7% Pref. ... ... | 10 | 7 % | 7 % | 7 % | 18½ — 19½ | 18½ — 19½ | ... | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock | Stock | ... | 4½% | 4½% | 107 —112 | 107 —112 | ... | ... |
| 60,000 | India-Rubber, Gutta Percha and Teleg. Works, Ltd. ... | 10 | 10 % | 10 % | 10 % | 20½ — 21½ | 20½ — 21½ | 21¼ | 21 |
| 300,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 1½% | 2⅞% | 2⅞% | 12⅞ — 13 | 12 13/16 — 12 15/16 | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 16½ — 16⅝ | 16½ — 16⅝ | ... | ... |
| 37,350 | Telegraph Constn. and Maintce., Ltd. ... ... ... | 12 | 20 % | 15 % | 15 % | 35 — 38 | 34 — 37 | 36 | 35 |
| 150,000 | Do. do. do. 5 % Bonds, red. 1899 | 100 | 5 % | 5 % | 5 % | 103 —106 | 103 —106 | .. | .. |
| 54,000£ | Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ... | 10 | ... | ... | ... | 10⅜ — 11¼ | 10⅜ — 11¼ | 11⅛ | 10⅞ |

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—2%; 1890—3%

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 7¼—7⅜.
Do. do. 7 % Preference, of £5, 9¼—9⅜.
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11½—12; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8⅜. Dividend for 1896—6 %.

* From Birmingham Share List.

**Bank rate of discount, 3 per cent. (February 4th, 1897).**

## THE HAMPSTEAD FATALITY.

Report on a Fatal Accident in connection with the Supply of Electric Energy at Hampstead on March 6th, 1897.

Sir,—I have the honour to report that I have inquired into the circumstances connected with the death, on the 6th instant, of H. White, a labourer employed on the electric lighting works of the Hampstead Vestry.

There is, I think, no doubt that the man was killed by an electric shock.

The accident occurred at one of the transforming stations. These are small chambers under the pavement, in this case only 6 feet 6 inches by 5 feet in plan, and 6 feet 6 inches high to the crown of the arch. Two transformers were contained in this chamber—one of a power of 25 kilowatts and the other 18 kilowatts. These were arranged on each side of an iron ladder provided as a means of access, and nearly filled the whole of the available space.

White's duty at the time was to empty the pans placed under the cover of the chamber to catch water. He was accompanied by T. Gill, a jointer in the service of the Vestry.

The chamber where the accident occurred is at the corner of Wedderburn Road and Lyndhurst Gardens. White was descending the ladder, and put one foot on the flat top of a transformer case.

This case was evidently at the time charged to a high potential from earth, while the ladder on which he had his hands was in connection with earth by resting against the iron frame of the cover of the chamber, which was in contact with the wet earth under the pavement. His boots were very wet at the time, and made good electric contact. In this way the unfortunate man received a very severe shock, which fixed his muscles and prevented him making any movement to release himself. Gill, who was waiting close to the entrance to the chamber, observed White's condition, but apparently could not effectively assist him, owing to the very limited space and the position of White's body.

Gill therefore ran down to the generating station and had the pressure cut off from the circuit, and White was afterwards extracted, but it was found that life was extinct.

Gill stated in his evidence at the inquest that White fell across the other transformer, and he was probably dead before this occurred. I was informed that White's hands and one foot were badly burnt, showing that it was while he had hold of the ladder that the fatal current passed. The accident was clearly due to the transformer case on which the man stepped having become charged.

It should have been impossible for this to occur; but I regret to have to report that, in my opinion, the precautions taken were insufficient and illusory, and, moreover, were not in accordance with the system of supply approved by the Board of Trade.

In order to prevent the possibility that the transformer case should become charged from the high pressure circuit, it is necessary that it should be connected to earth efficiently, so that before its potential can be raised to a dangerous amount, the resulting current passing from the high pressure circuit to earth by means of this connection shall cause the fuse or other automatic cut-off to act.

In this case the only earth connection made was to an iron bolt let into the wall of the chamber, and upon which an insulator was supported. This bolt could at best have a very limited extent of surface in contact with moist earth, and I do not think that it would have been considered sufficient even for telegraphic purposes. It is much to be regretted that a more efficient means of earth connection was not adopted.

The fault in the high pressure connection, by means of which the transformer case became charged, was, I was informed, caused by the insulation of the connecting wire having become damaged where it passed through the iron case.

It was with the greatest surprise that I ascertained that the holes in the iron case through which these connections passed were not bouched with non-conducting material in any way, and that an ordinary India-rubber-covered wire had been passed through this hole and then bent down through a right angle to reach the high pressure terminal.

In my opinion such an arrangement is well calculated to produce the fault that occurred. In the description of system approved by the Board of Trade under the Hampstead Electric Lighting Order, it is specified that all metal used in the construction of the transforming stations, and all exposed metal contained within them, will be electrically connected to the armouring of the mains, and, further, that all high pressure conductors and apparatus will be so protected as to prevent danger from electric shock. It is to be regretted that these arrangements had not been carried out.

This unfortunate accident again directs attention to the dangers to which the employés of electric light undertakers using high pressure are exposed, and the necessity for some supervision and control of the means adopted by these undertakers for the prevention of such dangers, similar to that provided under the Factory Acts for the protection of employés from other recognised dangers.

In the present case the following recommendations should, I consider, be brought to the notice of the Hampstead Vestry for their immediate attention:—

1. They should improve the earth connection of all transformer

cases, and test the efficiency of these earth connections at least once a month, by trying whether an artificially-made connection of the case to the high pressure circuit will at once cause the cut-out provided to act, using for the purposes of this test a pressure of one-quarter the working pressure. Such a test can be easily arranged.

2. Electrically connect together the transformer cases and the iron ladders and any other metallic body contained within the chamber, and not forming part of the electric circuit.

3. Have all holes in the transformer casing through which high pressure connections pass bouched with suitable and effective non-conducting material.

4. Have all high pressure connections as far as possible enclosed in metal casing efficiently connected to earth.

5. It is also, I consider, very desirable that arrangements should be made for cutting off both the high and the low pressure from these transformer chambers conveniently from the outside.

6. Finally the undertakers should carefully comply with the conditions specified in their description of system, and referred to above, which provide for an efficient earth connection and for the connection specified in recommendation 2. Had they been complied with, this acident would certainly have been prevented.

The chambers constructed by the Hampstead Vestry are very restricted in size, and it is hardly possible to provide against every danger that may attend a man, especially if ignorant of the laws of electrical action, or careless by nature, if he has to enter and work in such a place when closely surrounded by conductors charged to high pressure.

I have, &c.,
P. Cardew, *Major.*

The Assistant Secretary,
Harbour Department, Board of Trade.
*March 12th*, 1897.

## MULTIPHASE INDUCTION MOTORS.

By A. C. Eborall, A.I.E.E.

(*Continued from page* 474.)

In addition to the form of motor shown in fig. 17, the firm has several other standard types, the difference being only in the mechanical design. For slow speed the latter is generally more open, owing to the increase of diameter necessary. Thus the photograph shown in fig. 18 represents a standard multiphase induction motor of 300 H.P., and speed of 200 revolutions at 40 ~. Several motors of this size and type are at the present time running at 5,000 volts in Cairo.

Messrs. Brown built such motors up to any tension; the excellent form of stator winding used renders the insulating of the coils as effective as in any transformer. The maximum voltage in the rotor is quite low; for instance, with the motor at rest, and the brushes off the rings, the tension between any two of the latter would be in general about 300 volts, with 5,000 volts on the stator coils.

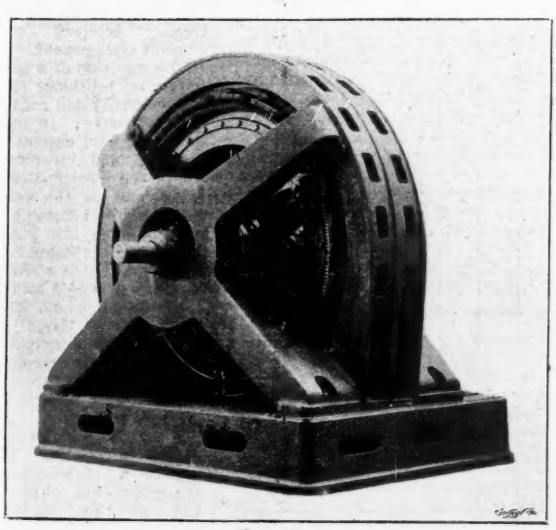


Fig. 18.

Just as a transformer may be used to step up or down, so may the rotating field in an induction motor be produced in either stationary or rotating part. Several firms have built motors so arranged that the line currents are led into the rotor, and the stator short-circuited. There is a certain amount of advantage in this, because the internal part, whether it is the inducing system, or seat of induced currents, necessarily contains the least volume of iron, and it would therefore appear as if a gain might result by making it the inducing system, because the iron losses in the latter depend on the frequency of supply, while those in the other part depend only on the slip, and hence are very small.

But it is very doubtful whether the advantages gained by this construction counterbalance the disadvantages of having the line currents in the rotating part. In the case of high tension motors, it is far preferable to lead them into the stationary part, where the maintenance of the necessary insulation is far easier, and the risk of breakdown less. However, this construction has been advocated by several experienced engineers, notably by Mr. Dobrowolsky, of Berlin.

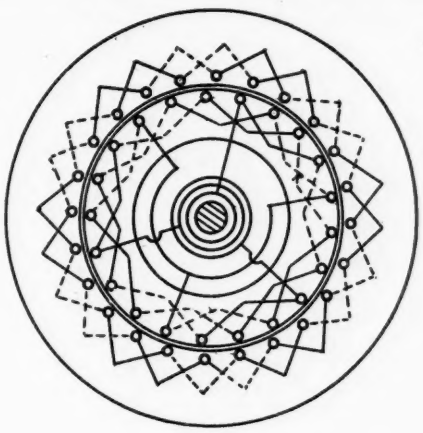


Fig. 19.

The early motors shown at Frankfort, and designed by him, were all on this plan. A diagram of such a motor with the windings is given in fig. 19.

### III.—The Running of Induction Motors.

In considering the general action of multiphase motors in the first section of this paper, it was stated that the rotor behaves in regard to the stator just as the secondary of a transformer behaves to the primary. It would therefore seem that motor problems could be treated in a manner similar to transformer problems—and to a large extent this is really the case, the error arising by so doing being practically negligible in well designed motors.

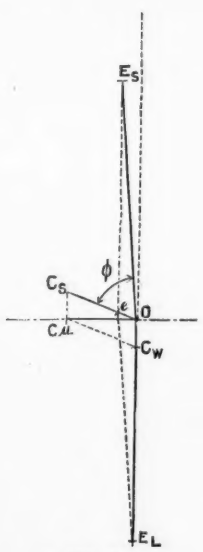



Fig. 20.

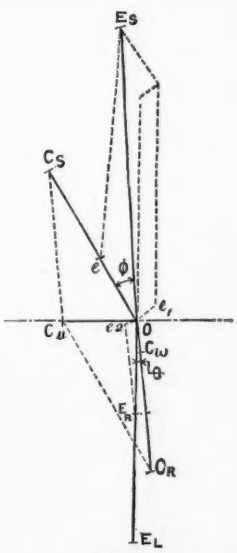



Fig. 21.

For instance, at no load, when leakage is practically absent, the watts in the rotor may be taken as being equal to the watts in the stator. This assumption is sometimes found useful in the testing of large motors.

Again, the running conditions of an induction motor at different stages can be plainly illustrated by vector diagrams. Thus fig. 20 shows the condition of affairs with a motor running light. The magnetising ampere-turns, o $c_u$, are set off horizontally—they are the resultant of primary and secondary ampere-turns. As the motor is running light, its only load is that due to iron losses and friction. The ampere-turns required for these losses will therefore be set off at right angles to o $c_u$, namely, o $c_w$. Completing the parallelogram gives o $c_s$ as the necessary primary ampere-turns at no load. To get the lag, the pressure which is effective in making up the iron and copper losses is set off along o $c_w$, giving the point o $e$. This latter vector, taken in conjunction with the back E.M.F. of the stator coils

O $E_1$, gives O E, as the impressed E.M.F. on the stator coils, and $\phi$ as the angle of lag at no load.

Should the actual no load current of a motor be much greater than that found as above, the difference, if not caused by bad iron or a mistake in the size of the air-gap, must be due to false rotor currents, that is, the rotor conductors have either been wrongly spaced out, or else there is considerable magnetic leakage from the stator; in other words, faulty design. If there is much slip with the motor running light, as well as a large stator current, the design is most probably at fault.

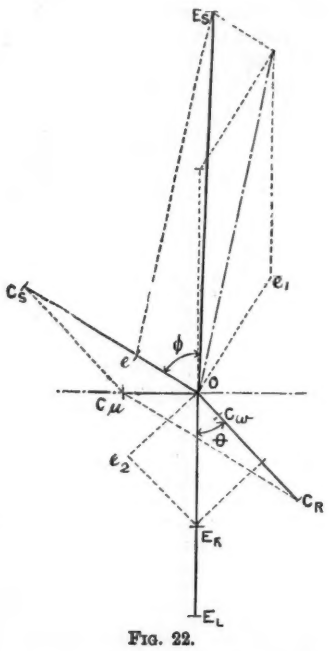



Fig. 22.

Fig. 21 shows the condition of a loaded motor. Here, owing to the demagnetising effect of the rotor currents, and to the presence of an air-gap, there is a certain amount of leakage, the magnitude of this depending on the design of the motor. Its effect is exactly the same as if a self-induction was introduced into stator and rotor windings. On the above diagram, o $C_r$ represents the rotor ampere-turns, lagging behind the rotor E.M.F. o $E_r$, by an angle, $\theta$. The E.M.Fs. due to leakage, are shown as o $e_1$ and o $e_2$ in stator and rotor respectively, and the other quantities represented as in fig. 20.

With the motor running at load, it will be seen that the lag between stator E.M.F. and current is much less than when running light; the leakage tends to make it larger, but the reduced impedance of the stator due to the rotor currents more than compensates for this, because in modern motors of good design the leakage between the limits of running light and fully loaded is very small, and the self-induction of the rotor not very much.

Fig. 22 shows the diagram of a motor when starting. Now in this case, with the rotor just beginning to move, the slip is practically identical with the frequency of the supply currents, and the whole arrangement (unless a resistance is put in the rotor) is just like a short-circuited transformer. Hence there will be large currents in rotor and stator, which, if it was not for leakage, would produce a great torque. But, as has been said before, leakage acts as if choking coils were introduced in rotor and stator, and hence these large currents will only have a great lag, and consequently only a small torque is produced. An inspection of fig. 22 shows that both $\theta$ and $\phi$ are very large.

It may be remarked in passing, that the diagrams shown in figs. 20, 21 and 22 are not by any means to scale, the details being purposely distorted in order to show the relation between the different quantities more clearly. The lost volts in fig. 22 have been made to have the same value as those at full load in fig. 21, and such a diagram would really only represent the case of a motor provided with one of the starting devices presently to be described. The iron losses have been taken as constant, an assumption not strictly true, as those in the rotor obviously depend on the slip, being a maximum at starting. But these assumptions do not affect the diagrams much, the aim of the author being to show the relations of the quantities rather than their numerical values.

Going back to the case of a motor starting, it is clear that if the rotor is of the simple short circuited type, a large rotor current is unavoidable. Now if the motor is at all large, such a current is harmful in several ways—

1. It draws a large wattless current from the mains, greatly disturbing the circuit on account of the voltage drop in the lines and generator, and also on account of the great demagnetising effect which it produces on the generator fields.

2. In the motor it exerts a very powerful demagnetising effect on the stator, choking back the induction, and hence diminishing the torque.

3. The rotor current being nearly wattless, it is out of phase with regard to the induction produced by the stator, and consequently the torque produced is insignificant.

4. Much of the impressed voltage may be lost in the stator coils to overcome resistance, and

5. If the motor is not starting on a loose pulley, so that it may quickly run up to speed, serious damage may be caused to the windings.

Of course, as soon as the rotor begins to move, the rotor currents decrease owing to the slip decreasing, and they will continue to decrease until the motor approaches its speed limit, determined by the stator poles and frequency of supply.

From what has been said above, it is clear that both for the sake of the motor and for the line, these large wattless currents must be reduced, and in the case of a large motor this becomes absolutely necessary. The best way of decreasing the wattless current in amount, and also of bringing it more into phase, is to put a non-inductive resistance in series with the short-circuited part at starting, cutting it out as the rotor runs up to speed. This means that the short-circuited part must be wound with a regular winding, and (if it revolves) its ends connected to slip rings on the shaft, in accordance with what has been already said in Section II.—or the ends may be connected to a resistance placed in the body of the rotor, which may be short-circuited by an external device when the rotor has got up speed.

The former plan of having the resistance exterior to the motor is on the whole preferable to the latter, as it allows the resistance to be varied and gradually cut out, which permits the motor to start with a current proportional to its load, and does not disturb the circuit so much.

The resistance for this purpose must be as non-inductive as possible; if not, it may still further increase the lag. As it will in general only be used at starting, the current density in the coils may be quite large, especially if it is enclosed in a box filled with oil. The starting resistances for the motors shown in figs. 17 and 18 are arranged on this plan—a star connected non-inductive nickeline resistance being enclosed in a circular cast-iron box filled with oil, and the contacts (capable of giving seven gradual degrees of variation to the short-circuited position) being arranged on the marble cover. The whole forms an extremely compact and efficient arrangement.

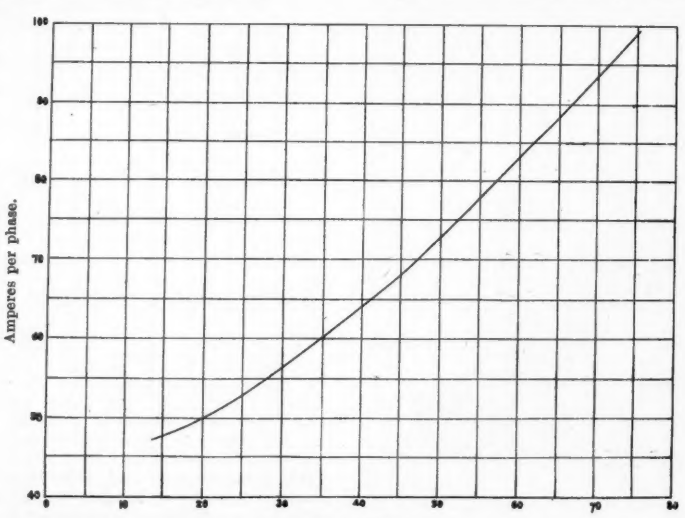



Fig. 23.

This insertion of a non-inductive resistance into the short-circuited coils is very effective; it cuts down the rotor current in amount, and therefore limits the demagnetising effect, and at the same time the rotor current is brought more into phase (and hence the stator current also), and as a result a greatly increased torque is produced, which may be made as large as desired. The other harmful effects enumerated above are in consequence either greatly reduced, or obviated altogether.

Figs. 23 and 24 are curves illustrating the use of a resistance in the rotor. Fig. 23 shows the connection between the static starting torque and the current taken in a 10 H.P. three-phase motor, the E.M.F. of supply being constant, and the rotor resistance varied in the above manner. The full load running torque of this motor was 35 lbs., and the current at this load 55 amperes. It will be seen that practically any torque may be got with a quite moderate current consumption, by properly varying the non-inductive resistance in series with the rotor windings.

Curve A, in fig. 24, shows the variation of speed with current in a 15 H.P. four-pole three-phase motor. The curve is very nearly a straight line, and approximates very closely to the corresponding curve of a series direct current motor. The variation of the power

factor is shown by curve B, and of the current by curve C, the pressure of supply being constant.

All the curves shown in figs. 23 and 24 were taken by Dr. Louis Bell on motors of American design, but are fairly representative of what can be done with well designed induction motors.

The corresponding curves for two-phase motors are practically identical as to torque, but the power factor would not be quite so high.

*(To be continued.)*

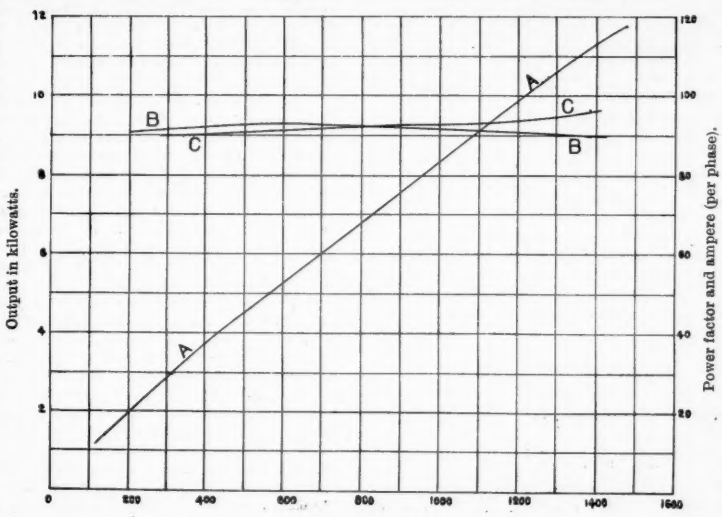
# PROCEEDINGS OF SOCIETIES.

## Institution of Electrical Engineers.

### Discussion on Mr. H. Benest's Paper.

Mr. Benest's theory that the cable breaks, described in his paper, were caused by a submarine river found a number of supporters, though the majority of the authorities appeared to think the evidence was insufficient.

Mr. Buchanan, F.R.S., said that though the bottom of the sea forms about three-quarters of the earth's surface, nothing was known about it 20 years ago. Such papers as this of Mr. Benest's were to be commended as adding something to our knowledge of this important subject. A submarine cable was a very expensive article, and was, therefore, worth looking after. The submarine gullies off the mouth of the Congo, he considered, were not formed by a submarine outlet, but by a return under current of sea water which prevented the deposition of the river mud in its course; the result being that the sediment was heaped up on each side, and gave to the sea bottom a fallacious appearance of a gully produced by erosion. He considered that the evidence was insufficient to prove Mr. Benest's contention that the gully shown on his chart was due to the submarine marine outlet of an underground river.




Multiphase Induction Motors.—Fig. 24.

Admiral Wharton, hydrographer to the Admiralty, said he took a great interest in the sea, both over and underneath, but he did not believe in submarine rivers having much force. He thought the cable may have been broken in the act of recovery.

Mr. Chas. Bright said he had read recently that, "happy was the cable that had no history," but it might be said, at least, that the cable with a history benefited science. Some of Mr. Benest's descriptions were worthy of Marryat or Kingsley, but as to his theory of the submarine river, he thought there were several objections to its acceptance. For instance, it was highly improbable that pieces of carpet and other refuse of human habitation should be discharged from an artesian well. The proximity of the mouth of the Senegal River was a more likely explanation of the appearance of these fragments. Specimens of the sea bottom should be kept for analysis in closed receptacles as they were liable to change by exposure to the air. He wished to get some information from the author as to the behaviour of rubber covered cables.

Mr. Preece said the paper had made a considerable addition to our knowledge of submarine cables. It showed how much geographers were indebted to telegraph engineers. He considered that the high temperature at the sea bottom was evidence of the existence of a current, though it perhaps was not sufficient to prove the existence of the Benest river. Mr. Preece pointed out the common mistake made by many speakers and writers in speaking of the "knot" as a unit of length, instead of as a unit of velocity—a correction which did not appear to have produced much impression on some of the subsequent speakers. He had no doubt that cables were sometimes broken by volcanic agency, and instanced some examples on East African and Australian cables. The proposed Pacific cable would run over a region known to be subject in some parts to volcanic action, and, therefore, it was of the greatest importance that a previous survey should be made of the sea bottom. In a paper read in 1859 he had said that the sea bottom should be surveyed before a submarine cable was laid. His proposition was met by the derisive laughter with which ignorance always greets words of wisdom, but since then wisdom had, as usual, been justified of her children.

Mr. March Webb considered that the contour of the bottom gave no clue to the cause of the break. He regretted that such papers as Mr. Benest's were not oftener read. Usually great reticence was observed as to faults, owing, among other reasons, to the speed of repairs leaving no time for careful measurements. He observed that Mr. Benest had taken no bottom densities. The chart of soundings appeared to show the existence of a gully which might be due to the former scouring out action of a river. He had no doubt as to the existence of rivers with subterranean flow; on the Peruvian Coast, a stream of fresh water had been found on digging into the sand. In his opinion there was some connection between the lost river on shore, the submarine gully and the damage to the cable.

Captain Wilson Barker thought the injury might be due to hot springs charged with corrosive substances. Great praise was due to the Silverton Company for the trouble they had taken to obtain complete soundings. The speaker described his plan for preserving specimens from the action of the air, which consisted in enclosing them in a glass tube corked at both ends. He remarked that great mistakes were often made by inexperienced persons in reporting the composition of soundings.

Mr. Donovan described some breaks that occurred in the West Indies which he considered to be due to growths on the cable. He quoted Mr. Murray's opinion that sulphuretted hydrogen generated by the decomposition, of vegetable matter might exercise a corrosive action on cables.

Captain Thomson had no doubt that cables were often broken by movements of the sea bottom. The temperatures, he thought, were normal for the depths in question.

Captain Goodsall considered that the break in this case was due to suspension. He was of the opinion that all breaks at over 1,000 fathoms depth were due to suspension.

Captain Lugard mentioned some curious cases of cable breaks on the Peruvian coast which occurred repeatedly in the month of March, *i.e.*, in the rainy season. A gully exisited, in this case having sides of clay and pebbles in the centre. The cable broke several times till it was carried seven miles further west, out of the influence of the scour in the gully. In this neighbourhood the natives recorded the existence of lakes that had a submarine outlet. He had met with another example of a submarine river in the West Indies. He had no doubt that cables were often broken by submarine streams.

Mr. Robert K. Gray, said that the repair of a cable break may cost as much as £5,000, and that, therefore, any information that would obviate their occurrence was of great value. He mentioned one of the African cables that was interrupted regularly in the month of March eight years in succession. Sir James Anderson was of the opinion that these interruptions were due to the welling up of fresh water. He laid the cable further inland, and no break has occurred since. There were other instances in which cables had been preserved from interruption in the same way. He has no doubt as to the existence of submarine streams, and that these are the cause of interruption in cables.

Communications were read from Prof. Milne and Mr. Rymer Jones, and Mr. Benest's reply, owing to the lateness of the hour, was taken as read.

## The Institution of Civil Engineers.

At the ordinary meeting on Tuesday, March 30th, Mr. John Wolfe Barry, C.B., F.R.S., the President, in the chair, the paper read was on "Electric Lifts and Cranes," by Mr. Henry W. Ravenshaw, Assoc. M.Inst. C.E.

This communication referred to the application of the electric motor to the working of lifts and cranes. Where hydraulic power was available, its simplicity afforded many advantages, although in the ordinary form of hydraulic motor as great an amount of water was used with a light load as with a heavy one. The electric motor, however, only absorbed current in proportion to the work developed, and this fact alone justified its application in certain cases. The chief requirements of the motor were sparkless commutation, self-adjusting brushes, and automatic lubrication. Shunt machines were generally used on account of their regular speed with varying loads, a few turns of series winding were, however, sometimes added to give prompt starting. Worm-gearing was employed, and gave compactness and silent running, with a quick pitch for the worm; ball-bearings and an oil-bath were recommended. To give good results, however, the ball-races must be of high-class steel, and be ground perfectly true after hardening. A special form of rope-drum made by Messrs. Easton, Anderson & Goolden, Limited, and the Sprague Screw Elevator with ball-nut were described.

The regulating gear should provide prompt and accurate control, absence of jerks, small current consumption and regular speed. Resistance was necessary in the circuit of the motor at starting to prevent a great rush of current; and this should be controlled automatically, as it was impossible for the attendant to tell the

position of the switch when a hand-rope was used. The automatic controller used by the Otis Company was described, as well as an arrangement controlled by a centrifugal governor which had been designed and used by the author. Magnetic brakes were advocated, the cage being automatically stopped when the current was accidentally broken. The magnet should be fitted with non-inductive resistances to prevent sparking on breaking the circuit. Tests of an Otis elevator and a curve showing the energy consumed under varying loads were given, the cost per return trip with four persons to a height of 36·5 feet being 0·101 pence at 4d. per Board of Trade unit. The cost of an average trip with two persons to a height of 24·75 feet was 0·060 pence at 4d. per unit.

Electric cranes presented several marked advantages over those driven mechanically, owing to the flexibility of the control of the motor and the simplicity of the conductors for transmitting the power. The relative advantages of the use of a separate motor for each motion, and of a single motor and friction-clutches were discussed, the mechanical simplicity in the one case and the electrical simplicity in the other enabling either system to be used with good results. Tests were given of a 20-ton electric crane, at Woolwich Arsenal, arranged on the single motor principle, friction-clutches being used to actuate the various movements. The collectors for the current with the method used for insulating them were described. Owing to the special requirements of this crane much gearing was necessary, and a heavy chain-block, weighing nearly 2 tons was fitted. The efficiency was thus reduced, especially at light loads, and the horse-power delivered to the load, as well as that delivered to the block, was given to enable the mechanical losses to be more readily obtained. A total efficiency of 53·42 per cent. was obtained when the load on the hook only was considered, and of 58·28 per cent. when the weight of the block was included in the load. To drive the outer carriage at the rate of 54 feet per minute 8·4 E.H.P. was required, and 10·2 E.H.P. to traverse the load radially at the rate of 32·4 feet per minute, both with a load of 20 tons.

The paper was illustrated by drawings of the lifts and cranes described.

On Tuesday, April 6th, the discussion upon this paper was resumed.

## THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICITY.*

By W. B. ESSON, M.Inst.C.E., M I.E.E., &c.

(*Continued from page 476.*)

### II.—The Line.

The line conductors may be laid underground or carried overhead, but the latter plan is almost universally adopted. In the case of underground, the best practice is to use cables insulated with some fibrous material, impregnated with a resinous or bituminous compound, and lead sheathed. Over the sheathing it is yarned, then armoured by steel tapes, again yarned, and well compounded on the exterior. Needless to say, whether for the main transmission, or for use only where overhead wires are undesirable, the conductors must be concentric, or twisted together. Such a cable can be easily laid, and no skilled labour is required, save in making the joints. It is simply put in a trench, which is filled in again when the laying is completed. The question of its being in the wet or dry enters very little into account, provided it is not laid in a clay soil, which in time would prove detrimental to the lead covering. Before you on the table is a sample of concentric cable such as I describe, 20 miles of which were made for Messrs. Johnson & Phillips by Callender's Company. It has been laid down for the power plant at the Sheba Mine, and before shipment from London, every length was tested after 24 hours' immersion in water, with an alternating pressure of 10,000 volts between the conductors, and 5,000 volts between the outer conductor and the lead covering. The inner strand consists of 19 wires ·057 inch diameter, and has a cross section of a twentieth of a square inch when stranded. The outer conductor has also 19 wires of ·057 inch diameter, stranded on in two segments. The insulation between the inner and outer conductor is ·35 inch thick, and between the outer and the lead ·23 inch thick. The lead sheath is $\frac{1}{10}$-inch thick. On a bedding of jute above the lead are laid two steel tapes, and outside these is a finishing layer of jute yarn stranded on and dressed with hard compound. The outside diameter of the complete cable is 2·3 inches; its conductivity resistance is ·88 ohm per mile for each conductor; its insulation resistance above 1,500 megs. per mile between inner and outer conductors, and 800 megs. between outer and lead; its capacity is under $\frac{1}{4}$ microfarad per mile.

But as I have said, overhead conductors are in almost universal use. They are in any case much less costly than underground cables, they are more easily repaired in case of a breakdown, and are much better adapted for very high pressures. In putting them up the best telegraph practice is followed, though of necessity the scantlings are everywhere more substantial. The poles are spaced from 30 to 50 to the mile, and from 25 to 50 feet high as circumstances demand. They are generally of timber procurable in the district, for the Niagara to Buffalo transmission, for example, they are of white cedar, while for transmission lines in California they are of cedar or tamarack. But sometimes they are of the stronger and more durable material, iron, as for instance in the line now being erected by the Central Electric Works Company on the Rand.

The insulators are fixed on cross arms of wood or iron in the usual way, but they must be of special form to secure the high insulation necessary. Oil insulators of the pattern originally introduced by Messrs. Johnson & Phillips have been largely used, and the lines of the historical Lauffen and Frankfort transmission were carried on these. One well-known form is on the table. The insulator has an internal and external bell projection, and the former dips into an annular trough of oil, the trough being movable on the bolt so that it can be readily lowered for the purpose of cleaning by merely taking out a pin. The insulation is practically perfect in this form of insulator, even where moisture abounds, as before the current could go to ground it would have to cross a surface of oil. It will be seen that the oil trough is thoroughly protected from wet, and the insulator is particularly suited to climates where excess of moisture is present, and where, therefore, the additional care of the oil is well repaid by the extremely high insulation obtained. But for ordinary climates oil has been given up, and we rely upon insulators so designed that the current would have to leak over a long path before getting to ground. On the table is one of Johnson and Phillips's insulators for high voltage transmission work. It will be seen that it is made very deep, and that the sides of the grooves are perpendicular, so that there can be no lodgment of dirt or dust. An insulator of this form is quite suitable for a working pressure of 3,000 to 5,000 volts. An insulator supplied by the same firm for still higher pressures is here. Here it will be seen that the surface over which the current would have to pass to get to ground is very considerable, in the actual insulator it is 12 inches from the binding wire to the bolt, of which over 9 inches is on the underneath side. This insulator is made of the finest porcelain, fired at a very high temperature, it will stand a pressure of 100,000 volts before puncture, and is perfectly suitable for a working pressure of 10,000 volts. The insulators used for the Niagara-Buffalo transmission are of somewhat similar shape, but in the latter there is a gutter round the bottom of the outside bell designed so as to drain away the water on each side clear of the cross arm. The construction of the gutter is such that only at two points, both clear of the arm, can icicles form. For the Montmorency-Quebec transmission a somewhat similar insulator is used. It will be understood that on occasion special insulators have to be used as when the line goes up steep inclines, thus bringing considerable strain on the supports. At times, also, it has been found advisable to insulate the line wires for a few feet, where bound to the insulators, by means of wrapping them with sheet rubber and compounded tape.

As regards the conductors, we shall see later how their size is to be determined, but whether they are laid underground or fixed overhead, it is of the utmost importance that the generators, transformers, motors, &c., to which they are connected be efficiently guarded from lightning. It might, at first sight, be thought that there is no need to fix lightning guards to underground conductors, but the effects of induced discharges have to be guarded against just as carefully as have the effects of direct discharges. The kind of lightning guard in use for telegraph and telephone work is not adapted for power transmission. Generally the apparatus for the former consists of a simple spark gap, and as the electromotive force at which the circuits are worked is comparatively low, such a device serves the purpose for which it is intended most satisfactorily. But when there is a pressure of over 2,000 volts, and a reserve, it may be, of hundreds of horse-power available for maintaining across the gap an arc started by the lightning, it will be seen that in transmission work a somewhat different set of conditions comes into play. By the use of lightning guards, we endeavour to do two things, first to conduct the direct or induced lightning charge as quickly as possible to ground, and thereby prevent damage to the apparatus and machinery; secondly, in the case of overhead lines, to prevent the lightning from striking the conductors at all. In designing efficient guards to effect the first object, the difficulties encountered were solely due to the fact that to maintain an arc across a gap requires much less pressure than is required to start it; in other words, the pressure required to make a spark pass between two points in a normal atmosphere is enormously greater than the pressure which will maintain a large current between the same points when the space is filled with carbon particles or metallic vapours. If across an ordinary spark gap, between a high pressure line and ground, an arc were started by a lightning discharge, there would be nothing to prevent the generators from maintaining, after the discharge had passed, a large current across the gap, practically short-circuiting, and in all probability damaging themselves permanently before the fuses blow. Obviously, then, one of two courses has to be adopted. The first course is to provide a gap, which, though normally set to the amount which the lightning can jump, is automatically lengthened immediately the discharge has taken place to such dimensions, that the generators are unable to maintain an arc across it. Guards of this type have been devised by a great many inventors, the best known probably being the Thomson-Houston. In this the discharge takes place between two curved horns pointing upwards, and the arc when formed is repelled by an electro-magnet until it goes out, the distance between the curved horns gradually becoming too great for the machine pressure to keep it going. Though this guard acts very well, and generally breaks the arc promptly when formed, manifestly it would be much better to prevent an arc forming, and the second course open to us is to use a metal alloy, such that the starting of an arc in the gap becomes an impossibility. This is achieved in the Wurtz guard lying before you, an apparatus which recommends itself on the principle that "Prevention is better than cure." It consists of a row of metal cylinders 1 inch diameter, by 3 inches long, placed side by side parallel to each other, and each separated from its neighbour by a gap of $\frac{1}{32}$-inch. The metal is an alloy of zinc and antimony, and when a discharge has passed, there is nothing to mark the

* Paper read before the Society of Arts on Wednesday, March 24th, 1897. From the Society of Arts *Journal*.

path it took, save a small pit or burn. With the cylinders spaced as above, an arc cannot be maintained between them, the dense oxide vapour produced being non-conducting, and unable to carry the current. This guard is always in a condition to protect the line, as the dimensions of the gaps are never altered, and so far as my experience goes, its action appears to be all that can be desired.

All lightning guards depend as regards their action on the fact that a lightning discharge prefers to make its way to ground across a small air gap rather than through the coils of the apparatus, which are in parallel with the path to ground. It will be apparent that coils possessed of self-induction, having an influence quite negligible when considered with reference to the working frequency, may offer enormous opposition to the course of the highly oscillatory discharge of lightning. Seldom therefore does lightning damage the machinery when a proper guard is used; but it is nevertheless often advisable to introduce chokers for the purpose of supplementing the opposition which the coils of the generators would offer alone to the discharge. These chokers consist of coils offering practically no opposition to the normal current, but choking effectually any attempt to go through them on the part of the lightning. The combination of Wurtz gap guards and chokers has been adopted with success for several transmission plants. Whether the conductors be underground or overhead, efficient guards, such as I have described, must be employed to protect the apparatus at both the generator and motor ends of the line; at intermediate points they are not required.

The guards described provide a path to ground for direct or induced charges, but as already stated, for overhead lines another kind of guard is employed, by which we endeavour to prevent the lightning from striking the line at all. If once the lines are struck, the guards already described will doubtless protect the apparatus; at the same time the precautionary measure of keeping, if possible, the lightning off the line is well worth taking. The well-known lightning spike used in telegraphy is the simplest of these guards. It consists of a pointed rod of wrought-iron, secured to the cross-arm by the insulator bolt, and having its point projecting some inches above the line. One of these spikes is fixed at each insulator, care being taken to make a thorough good connection from them to ground. A better guard is a bare iron wire running the whole length of the line, fastened on the top of the poles. This may be barbed fence wire, and it should be grounded every third or fourth pole. For the protection of the Niagara-Buffalo lines barbed wires are employed, grounded every 500 feet or so, for the Montmorency-Quebec lines strong galvanised iron wires are used run on the extreme ends of the top cross arms, while the Tivoli-Rome lines have a single wire run on the top of the posts. These methods of guarding have proved very efficient, but needless to say, the greatest care must be taken to ensure a good ground connection; failure in this respect may render the guards not only useless, but worse—an actual source of danger.

I now come to the size of conductor to be used, which depends on—

(*a*) The system to be used.
(*b*) The working pressure.
(*c*) The power to be transmitted.
(*d*) The loss permissible in the line.

The total weight of copper required for transmission by two-phase currents employing four wires is, with the same loss in the line and the same working pressure, exactly the same as required for single-phase transmission, though in the former case each wire has, of course, half the sectional area. This is on the supposition that the same type of motor is used, as it would not do, for comparison, to assume non-synchronous motors in one case, and synchronous motors in the other. Call this weight 1. If for the two-phase transmission we use three wires instead of four, making the third, which replaces two, common to both circuits, this third wire need not be double the area of each of the other two, but only 1·4 times, and under these circumstances the weight of copper will be ·85 against the former 1. If three-phase transmission, with three wires, is used, the figure for the relative weight of copper depends entirely upon what is assumed as the standard of comparison with reference to the strain upon the insulation of the line, and the apparatus connected to it. If we assume that there is between any two of the three wires the same difference of potentials that there is between each pair of wires comprising a circuit of the two-phase system, the weight of copper is represented by the figure ·75. So far, the weights are:—

| | |
|---|---|
| 1. Single-phase system, two wires... ... ... | 1·0 |
| 2. Two-phase system, four wires ... ... ... | 1·0 |
| 3. Two-phase system, three wires ... ... ... | ·85 |
| 4. Three-phase system, three wires ... ... | ·75 |

It will be seen that on the three-phase system the same power can be transmitted by three wires, as can be transmitted by four wires of the same size, working on two phases, it being assumed that the loss in the line is the same in both cases.

The second factor determining the size of conductors is the pressure to be adopted, this being one of the first things which has to be decided when a transmission scheme is being worked out. The pressure influences very materially the cost of line construction, as the weight of copper in the conductors is, for transmission, of the same power with the same loss in the line inversely as the square of the pressure. For economical reasons, therefore, it is desirable that a pressure be decided upon as high as the conditions render practicable, while for long lines high voltage is imperative.

We have seen that generators can be readily wound for pressures of from 2,000 to 5,000 volts; 25 horse-power motors can be wound for 1,000 volts, 50 horse-power for 2,000, and 75 to 100 horse-power for 3,000 volts. Still larger motors may be wound for 5,000 volts, and it should be remembered that with the high pressure part at rest, the exposed rotating part is subjected to no higher pressure than if the current entered the machine at only 100 volts. The high pressure part can be completely protected, so that it is impossible to touch it, consequently, high pressure is attended with no extra danger to the man in charge of the motors. It will be seen, then, that in the case of transmitting power to a group of large motors, there is no need to use step-up and step-down transformers as an essential part of the scheme until the distance exceeds that at which a pressure of from 3,000 to 5,000 volts is economical. Transformers need only be used to step-down the lighting circuits and for such motors as may be too small for winding for the line pressure.

In deciding upon the pressure, we have to consider the sizes of the motors we are going to use. Large motors may be worked at the line pressure just mentioned, but if the bulk of the energy is to be employed for motors of medium power it might pay to reduce the line pressure to a suitable figure for the bulk, putting more copper into the conductors, but saving the cost of transformers. If the motors rule so small, however, that the whole of the current has to be transformed, there is no use in working the line at less than 3,000 volts. It is desirable to illustrate these points by an example:—Suppose we have to deliver 300 H.P. at some distant point made up:—

| | | | |
|---|---|---|---|
| Ten motors of | 10 H.P. ... ... | = 100 | H.P. |
| Four „ | 25 „ ... ... | = 100 | „ |
| Two „ | 50 „ ... ... | = 100 | „ |
| Total | ... ... ... | 300 | H.P. |

Let us say that the limiting voltage for the winding of the motors is:—

| | | |
|---|---|---|
| For the | 10 H.P. motors ... ... | = 300 volts. |
| „ | 25 „ „ ... ... | = 1,000 „ |
| „ | 50 „ „ ... ... | = 2,000 „ |

We will leave 300 volts out of consideration as a pressure suitable for the lines. Taking transformers at 50s. per horse-power * all round, we have as an expenditure on transformers for different line pressures:—

| Working at | For the 10 H.P. motors. | For the 25 H.P. motors. | For the 50 H.P. motors. | Total transformers. |
|---|---|---|---|---|
| 1,000 volts... | £250 | ... | ... | £250 |
| 2,000 „ ... | £250 | £250 | ... | £500 |
| 5,000 „ ... | £250 | £250 | £250 | £750 |

This means that if we work at 5,000 volts, we require transformers for all the motors; if we work at 2,000 volts, we require them for the 25's and 10's, while if we work at 1,000, they are required for the 10's only. It thus appears that working at 1,000 volts, we could expend on the line about £500 more, and working at 2,000 volts, about £250 more than we could working at £5,000 volts, the total cost of the scheme coming out no higher. Taking copper at £65 per ton, and assuming for the time being that the other items making up the cost of the line are constant and independent of the size of the conductors, we can increase the weight of copper for 1,000 and 2,000 volts by about 7·7 tons and 3·85 tons respectively, over that required for 5,000 volts, and without increasing the cost of the installation. Whether these additions to the weight will be sufficient to keep the loss in the line the same as before, with the reduced pressure, will obviously depend upon the distance to which the power is to be transmitted, and in the following table the effect of distance is made clear.

Taking the figures for 1 mile, and adding to them the cost of transformers as already found, it will be seen that 1,000 volts gives for this distance the lowest cost. Doing the same with the 2-mile figures we have almost a tie between 2,000 and 5,000 volts, 1,000 is out of it; 5,000 has slightly the advantage, though it has always the advantage beyond 2 miles. With the same sizes of motors suppose the power to be increased to 600 H.P., and what happens? Here the cost of transformers, and also the cost of the copper, is doubled for the same percentage loss in the line, the result being that the increase from 2,000 to 5,000 should be made in both cases for the same distance from the generator. It is interesting to note from the table the distance at which it pays to step the pressure up to 10,000 volts. The step-up transformers would cost, at 50s. per H.P., £750, and adding this to the cost of the line for 10,000 volts at a distance of 10 miles, it will be observed that the figure comes to £1,060 against £1,240 for 5,000 volts without stepping up. It therefore appears that when the distance approaches 10 miles step-up transformers must be resorted to.

Cost of Line Wire to Transmit 300 H.P. to various Distances at various Pressures. Two-phase System.

Copper, £65 per ton. Power lost in line 10 per cent. = 30 H.P.

| Volts. | 1 mile. | 2 miles. | 5 miles. | 10 miles. | 20 miles. | 50 miles. |
|---|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ | £ |
| 1,000 | 310 | 1,240 | 7,750 | ... | ... | ... |
| 2,000 | 77·5 | 310 | 1,937 | 7,750 | ... | ... |
| 3,000 | 34·4 | 137 | 861 | 3,444 | 13,776 | ... |
| 5,000 | 12·4 | 49·6 | 310 | 1,240 | 4,960 | 31,000 |
| 10,000 | ... | ... | 77·5 | 310 | 1,240 | 7,750 |

It will be evident from what has gone before that the pressure to be adopted is decided by the distance, by the way in which the power is to be broken up at the receiving end, and by the loss permissible in the line. In the example given, I have merely indicated roughly how the engineer has to consider the matter before he can arrive at

* This allows for a power factor of ·75.

a decision. The copper and transformers are the chief items, and the rates for these may vary from the figures given, while, needless to remark, there is a host of minor factors which also have to be taken into account, and the influence of which cannot be neglected. It must not be thought that 10,000 volts is the limit of line pressure, though at the moment it is the exception. The pressure on the Hochfelden-Oerlikon line for the transmission of 900 horse-power for 25 miles is 13,000 volts, while the Ogden-Salt Lake line is to be worked at 15,000 volts. For the Niagara-Buffalo line, which is 25 miles long, the pressure will be 20,000 volts; while if currents from Niagara ever reach Albany, over 300 miles, in all probability they will have to be transmitted at a pressure of something over 50,000 volts.

Let us suppose that the pressure is decided upon, the table which follows gives the current in amperes per brake horse-power necessary to be transmitted. The pressure is, in all cases, taken at the motor end of the line, the pressure at the generator having to be higher by such amount as corresponds to the loss in the line. The current is for H.P. actually recoverable at the pulleys of the motors, it being assumed that the efficiency is about 90 per cent., and the power factor ·75.

Table I.

Current required per B.H.P. at various pressures.

| Pressure in volts. | Amperes. |
|---|---|
| 220 | 5·0 |
| 440 | 2·5 |
| 1,000 | 1·11 |
| 2,000 | ·55 |
| 3,000 | ·37 |
| 5,000 | ·222 |
| 10,000 | ·111 |

These figures are only to be taken as approximate. In the case of two-phases, half the above current flows in each circuit. For three-phases, the pressure in the table would apply to the difference of potentials between the common junction of the three conductors and either of the lines, and one-third of the current given in the table would flow in each wire.

*(To be continued.)*

## ELECTRICAL MATTERS IN LONDON.

### ST. PANCRAS VESTRY.

At the meeting on the 31st ult. the Electricity and Public Lighting Committee reported that they had received an application from Messrs. Crompton & Co. for a payment of £1,635 on account of their contract for supplying three engines and dynamos for the King's Road Station. The committee stated that in consequence of the delivery of the plant being overdue, penalties under the contract amounted to £220. Representatives from Messrs. Crompton & Co. had attended before the committee to discuss the question of the penalties not being enforced, and had agreed, subject to a certificate being at once issued, to pay by the way of penalties the sum of £75. The committee, having fully considered the whole of the circumstances of the case, recommended that the Vestry should sanction a cheque being drawn in favour of Messrs. Crompton & Co. for the amount claimed, less a sum of £75 to be deducted for penalties. This recommendation was adopted.

The same committee announced that they had had under consideration the question of providing additional plant for the Regent's Park station. The present engines and dynamos, with the assistance of the King's Road station, would, they stated, enable the coming winter load to be dealt with; but for the following winter additional plant would be required. The committee were informed that reputed makers of engines and dynamos would not accept any orders for delivery in less time than 14 months, and in view of this, the committee considered that immediate steps should be taken to ensure additional plant being ready to meet the winter load of 1898-9.

The committee accordingly recommended, and it was decided, to invite tenders, by public advertisement, for supplying two large engines and dynamos, condensing plant, &c., for the Regent's Park station, at an estimated cost of £11,600.

### LAMBETH VESTRY.

A recommendation is to be submitted by Mr. Street in favour of the appointment of an electrical engineer to watch the interests of the parish in the laying down of the electric lighting mains, plant, and the refuse destructor.

### ST. JAMES'S (WESTMINSTER) VESTRY.

It was reported by the Works Committee, at the meeting held on the 1st inst., that they had considered, pursuant to the vestry reference of March 18th, a letter from Messrs. Freeman & Co., applying for an advance of £500 further on account of the supply of arc lamps, columns, &c., in connection with the lighting of the main streets, and had considered in connection therewith a certificate from the vestry's surveyor for that amount, making, with the addition of the previous certificates, the sum of £2,250 paid to that company under their contract. Having been informed by the vestry's surveyor that the amount of materials supplied was in excess of that amount, the Committee recommended, and it was decided, to pass the certificate and refer it to the Finance Committee for payment.

### HAMMERSMITH VESTRY.

When the members of this Vestry met on the 31st ult., the Electric Lighting Committee reported that they had considered the form of application and conditions and terms of supply of the electric light, and that they had given them their approval.

The Imperial Tramways Company have been in negotiation with the Vestry with a view to making five extensions of the tramways in the district. In this connection the Special Committee submitted a letter received from Mr. Samuel White, the secretary of the company, detailing the proposal made a short time previously by the chairman and the managing director to the Works Committee.

The letter pointed out that the company were ready, if the Vestry were prepared to approve a Provisional Order or Act being granted, to at once submit the form of order or Act so that the necessary protective clauses might be settled. The letter proceeded:—

"It is understood that the Vestry will re-affirm their approval of electric traction, and again use their influence with the County Council to secure that body's approval, not only of the extensions mentioned but also of electric traction. In the event of the Vestry and County Council approving the proposed lines with such electric traction on the extensions and on the company's present system within the parish of Hammersmith, the company will immediately on the approval of the Provisional Order or Act, as the case may be, being duly completed, undertake the re-construction of the Goldhawk Road tramways principally as a double line, such re-construction to be carried out wholly at the cost of the company, and to include the whole of the company's tramway area, including the outer 18 inches. It is understood that concurrently with the re-laying of the Goldhawk Road tramway as before stated, the Vestry will lay the remaining portion of the road with wood paving, and that the company will pave with wood the whole of the new tramways for which approval is now being sought on a similar condition that the Vestry at the same time carry out the wood paving of their portions of the roads."

The Vestry decided not to agree to any extension until Goldhawk Road was paved with wood, and that in the meantime all extensions would be opposed.

### CLERKENWELL VESTRY.

Notices of motion appear to remain on the agenda paper of this Vestry as long as in the case of the London County Council. Since September 25th the following motion has appeared in the name of Mr. Evan Jones:—

That the advisability of the Vestry applying for a Provisional Order for supplying the parish with electric light be referred to a Special Committee for early consideration and report.

### ST. GEORGE'S (HANOVER SQUARE) VESTRY.

The Works Committee reported, at the meeting held on the 1st inst., that they had informed the superintending architect of the London County Council that they saw no objection to the erection of an addition to the generating station of the Westminster Electric Supply Corporation in Davies Street, according to the plan submitted.

### ST. MARTIN'S VESTRY.

The Lighting Committee submitted a report at the meeting held on the 1st inst., stating that they had had under consideration for a long time a letter from Mr. E. W. Seale, general manager and Secretary of the Charing Cross and Strand Electricity Supply Corporation, on the subject of lighting some of the streets by electricity. The corporation offered to undertake the work on the following terms:—

1. All the necessary mains, posts, lamps, and fittings to be respectively laid, erected, supplied, and fitted at the cost, in all things, of the Corporation.
2. All maintenance, labour, carboning, trimming, painting, and supervision to be provided and borne by the corporation.
3. The hours of lighting to be 3,950 per lamp per annum, any excess to be charged for at a price, *pro rata*, per lamp.
4. The lighting of the lamps to be undertaken by the corporation, and to be controlled from a switchboard at the central station.

An agreement to be entered into between the Corporation and the vestry for a term of 21 years, determinable at the end of the first seven or 14 years, on the purchase by the vestry of the installation on terms to be arranged.

The minimum number of lamps to be 60, of 10 amperes each. The price to be £28 per lamp per annum.

The Lighting Committee did, however, not make any recommendation on this proposal, which therefore was allowed to drop.

At the same time, the Committee reported having considered the report of the surveyor (Mr. Chas. Mason, A.M.I.C.E.), on the cost of lighting the principal streets by electricity, and by an improved system of lighting the side streets and courts by gas, as compared with the cost of the present system of lighting.

## ELECTRIC TRAMWAYS IN CONNECTICUT.

The State of Connecticut does not include a huge area, though it has managed to become famous for clocks, hard-headed citizens, and various other things, amongst which we may now fairly reckon electric tramways. For one single State to have practically as great a length of line as the whole of France, Germany, and three times as

much as Great Britain and Ireland, is rather humiliating for the older established countries, and tends to show that we have lots of lee way to make up in improved transit methods to give more rapid intercommunication.

The annual report of the State Railroad Commissioners for 1896 furnishes some instructive and interesting reading, and we quote the chief figures relating to electric lines, with the most important of them arranged in tabular fashion for easy reference.

The total length of line is stated to be 352 miles of track, 27 companies in all sending reports. Of these the table embodies 22. The entire cost of the 352 miles of track, &c., is stated to be three million sterling, and of the equipment £400,000, or more exactly £10,500 per mile complete. The gross earnings for the year amounted to £518,000, and the expenses to £341,000, or 65 per cent. of the receipts.

Electric Tramways in Connecticut.

| Number of line. | Miles of single track. | Cars. | | Number of employés. | Passengers carried. | Miles run. | Cost of electric power per car mile in pence. | Total cost per car mile in pence. |
|---|---|---|---|---|---|---|---|---|
| | | Closed. | Open. | | | | | |
| 1 | 50 | 45 | 71 | 200 | 6,383,503 | 1,721,147 | ·55 | 5 |
| 2 | 13 65 | 12 | 20 | 65 | 2,600,458 | 401,284 | 1·5 | 7 5 |
| 3 | 11·15 | 11 | 2 | 45 | 1,661,703 | 350,635 | 1·4 | 5·75 |
| 4 | 6 29 | 10 | 15 | 30 | 1,049,044 | 267,229 | ·65 | 8 |
| 5 | 20·56 | 53 | 46 | 186 | 5,538,585 | 1,308,660 | ·6 | 7·6 |
| 6 | 64·71 | 78 | 89 | 470 | 10,854,971 | 2,814,072 | ·95 | 6·5 |
| 7 | 13 | 12 | 15 | 60 | 631,836 | 254,835 | 1·6 | 9·5 |
| 8 | 10 5 | 8 | 13 | 24 | 629,655 | 337,260 | 1·2 | 6 |
| 9 | 17 | 21 | 25 | 75 | 2,161.094 | 583,951 | 1·2 | 6·4 |
| 10 | 4·75 | 4 | 9 | 15 | 487,954 | 117,598 | 2 | 6·7 |
| 11 | 11 25 | 10 | 10 | 33 | 1,181,558 | 300,408 | 1·65 | 5·75 |
| 12 | 25·5 | 34 | 39 | 165 | 4,466,080 | 1,181,206 | 1·1 | 5 |
| 13 | 7·2 | 6 | 16 | 23 | 1,136,548 | 212,323 | 1·8 | 7 |
| 14 | 7·25 | 9 | 9 | 27 | 1,099,843 | 241,532 | 1·45 | 8 |
| 15 | 16 85 | 8 | 16 | 30 | 1,126,875 | 289,290 | 1·2 | 5·7 |
| 16 | 12 46 | 13 | 14 | 45 | 1,987,519 | 297,265 | 1·8 | 9 |
| 17 | 1·5 | 3 | — | 7 | 101,958 | 49,385 | 1·1 | 5 |
| 18 | 10·24 | 6 | 7 | 27 | 629,082 | 183,060 | 2·2 | 6·7 |
| 19 | 11 46 | 20 | 26 | 75 | 2,823,684 | 490,056 | 1·5 | 7 |
| 20 | 5 25 | 3 | 2 | 8 | 157.555 | 61,320 | 1·0 | 5 |
| 21 | 4·11 | 3 | 2 | 5 | 6,669 | 3,916 | 1·8 | 15 |
| 22 | 16·77 | 39 | 51 | 150 | 5,345,848 | 921,468 | 1·0 | 8 |
| Totals and averages | 341 45 | 408 | 498 | 1.765 | 51,961,922 | 10,387,900 | 1·3 | 7 |

This averages out to about 10d. and 6¼d. respectively per car mile. The average dividend is nearly 4 per cent.

Several interesting conclusions may be drawn from the accompanying table, prepared from the figures given in the report. In the first place, it is very evident that Americans are by no means averse to crowding the cars if we may judge from their fondness for open cars, which proverbially carry as many passengers as are able to hang on by their teeth or eyelashes. Secondly, the cars average all round an annual mileage of about 11,542 each, or, say, 35 per day, which is rather a low average for electric service, and barely a third of the usual daily mileage.

The number of passengers carried does not seem to bear the same high average proportion to miles run as obtains in this country. Most English lines carry about 10 passengers per mile run, or twice as many as these American lines. It may be imagined, therefore, what fine prospects there ought to be for tramways here when converted, and the already dense traffic made still more dense.

The cost of electric power per car mile—averaged out at 1·3 penny—does not seem very high, being practically equivalent to the same amount per unit, but the total cost is considerably higher than it need fairly be. Sevenpence per unit is rather excessive, even when due allowance is made for expensive labour and costly management. It does not appear that any allowance is made in this average cost for depreciation or a reserve fund, but the accounts are presented in a manner hardly up to our Board of Trade standards, and perhaps we do the figures an injustice.

The lines pay a diviend anyway, and we see no reason why the dividend should not be earned.

## MANUFACTURE OF CELLULOID.

Celluloid is made by the combined action of pressure and heat, or with the aid of solvents, in that case in the cold, says the *Trade Journals' Review*. The camphor is dissolved in alcohol, as little as possible, and the solution sprayed through a rose on to the pyroxyline, which must be perfectly dry. A second layer of pyroxyline is added, moistened again with camphor solution, and so on. The gelatinous lump is worked between iron rollers to which it adheres; the layer is slit longitudinally and rolled again. The cakes, 0·4 inch thick, are cut into plates, about 2 feet by 1 foot, which pass for 24 hours into hydraulic presses, which are doubly steam-jacketed. The mass is now sawn into plates, which are dried at about 95° Fah. for a week or two, and finally cut into smaller pieces, from which the articles are stamped. Further particulars are difficult to obtain. A writer in the *Gummi Zeitung* believes, however, that Magnus and Co., of Berlin, pour 100 parts of ether on 50 of collodion wool and 25 of camphor, and stir the covered mass in earthenware vessels with rubber sticks until a homogeneous gelatinous mass is obtained, which is then rolled. At St. Denis ethyl alcohol is said to be used. Apart from dyestuff and other additions the celluloid consists on an average of two-thirds of pyroxyline and one-third of camphor; more camphor imparts an unpleasant smell and impairs the strength of the product. The chemical constitution of celluloid is still doubtful.

The celluloid is generally supplied in rods of 3 feet length, or in plates of 30 inches by 12 inches, of a yellowish colour, unless dyed. It cannot be exploded by heat, blows, nor friction. It burns, but the flame can easily be blown out; it leaves an ash skeleton, which continues to sparkle faintly for some time. It is soluble in ether-alcohol, while either of the ingredients alone only attacks the camphor. Concentrated acids and caustic alkalies decompose or carbonise the celluloid. While the finished article is not dangerous, the manufacture is highly so. Various additions to render the celluloid less inflammable are hardly required. The smaller articles are cut ready in the cold, dipped into hot water, bent and shaped, and plunged into cold water again to retain their shape. Larger articles are pressed in heated moulds. If reheated during further operations the articles lose their shape. The comb manufacture is simpler than with hard rubber. The teeth are stamped with dies, by hand or machinery, and then polished with pumice stone and cold water. The dyes are generally added at the time when the pyroxyline and camphor are mixed. Striped articles are obtained by superposition of plates of different colours and cross cutting of the compressed blocks. Surface dyes may be dissolved in acetic acid or acetic ethers, which slightly attack the celluloid.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

7,366. "Electric culinary appliances." G. E. Dutertre. Dated March 22nd.

7,368. "Improvements in and relating to an improved method of printing by means of electricity." A. A. Collings. Dated March 22nd.

7,373. "Improvements in apparatus for controlling the action of electric motors at a distance." W. O. Smith and G. K. B. Elphinstone. Dated March 22nd.

7,381. "Improvements in electric glow lamps." P. Scharf. Dated March 22nd.

7,398. "Improvements in terminal clamps for electric wires." A. E. Wrottesley. Dated March 22nd.

7,405. "Improvements in prepaid or coin-freed electric meters." C. W. S. Crawley and A. Soames. Dated March 22nd.

7,412. "An improved telephone switchboard indicator or annunciator." N. H. Holland. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 2nd, 1896, being date of application in Canada.) Dated March 22nd. (*Complete.*)

7,415. "A new or improved electric advertising sign." W. R. N. Gard. Dated March 22nd.

7,420. "Improvements in electrical resistances." A. J. Marquand. Dated March 22nd.

7,421. "Improvements in or connected with the electric lighting of buildings or other areas particularly applicable to fire brigade stations, asylums, hospitals, hotels, ships, and like institutions." R. F. K. Stubbs. Dated March 22nd.

7,462. "Improvements in the permanent way and wheels for electric cars." R. C. Sayer. Dated March 23rd. (*Complete.*)

7,474. "Improvements in telegraphically operated signals." J. N. Newsom. Dated March 23rd. (*Complete.*)

7,487. "Improvements in or relating to automatic speed governors for electrically propelled vehicles." A. K. Baylor. Dated March 23rd.

7,497. "Improvements in regulable transformers and in regulating alternating current dynamo-electric machines." H. H. Lake. (General Electric Company, United States.) Dated March 23rd. (*Complete.*)

7,532. "Improvements in the combined electrolytic and leaching treatment of zinc bearing ores and zinc bearing products." E. A. Ashcroft. Dated March 23rd.

7,545. "Improvements in the manufacture of filaments suitable for electric lamps." J. H. Douglas-Willan and F. E. W. Bowan. Dated March 23rd.

7,645. "Improvements for preventing installations for electrical transmission of energy, in particular electrical railways, from causing disturbances in telephonic circuits." Siemens Bros. & Co. (Siemens and Halske, Germany.) Dated March 24th.

7,646. "Improvements in electrical motor generators." Siemens and Co. and H. C. Leake. Dated March 24th.

7,671. "Improved means of applying the heat of the electric arc for welding, soldering, and other purposes." R. B. Roxby. (A. Hirsch, Germany.) Dated March 24th.

7,772. "Improvements in alternating current motors." W. Langdon-Davies. Dated March 25th.

7,774. "Improvements in selective signal apparatus for party telephone lines." J. E. Kingsbury. (The Western Electric Company, United States.) Dated March 25th. (*Complete.*)

7,775. "Improvements in or relating to electrodes for secondary batteries. W. J. S. Barber-Starkey. Dated March 25th.

7,823. "Improvements in electric switches." E. W. Cowan and A. Still. Dated March 26th.

7,824. "An improved method of controlling alternating current electric circuits." E. W. Cowan and A. Still. Dated March 26th.

7,868. "Improvements in electrical clocks and similar instruments." F. Hope-Jones and G. B. Bowell. Dated March 26th.

7,870. "Improvements in or relating to dynamos or electric motors and in apparatus for driving fans by electricity." J. W. Gibbs. Dated March 25th.

7,950. "Improvements in wheels or pulleys for receiving and transmitting motive power by cords, bands, chains, or connecting rods which improvements are applicable to velocipedes, motor cars, electric generators, and various classes of high speed machinery." F. Hurd. Dated March 27th.

7,955. "Improvements in the electric propulsion of vehicles and apparatus therefore." Siemens Bros. & Co. (Siemens & Halske, Germany.) Dated March 27th.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

### 1896.

533. "Improved automatic remontoir apparatus for 'Hughes' telegraphic apparatus." Siemens Bros. & Co., Ltd. (A communication from Siemens & Halske.) Dated January 8th, 1896. Relates to an automatic apparatus for winding up the driving weight in a Hughes telegraphic apparatus, and consists in providing a cylinder, which by means of a cock and tumbler operated on by the driving weight as it descends and ascends is put into communication with an air pressure or vacuum vessel. A piston or diaphragm is connected to the driving gear thus subjected to pressure so that the weight is wound up. 1 claim.

1,480. "Improvements in electric gas lighting apparatus." E. G. Brewer. (A communicatiom from H. C. Farquaharson and D. F. Root.) Dated January 21st, 1896. Relates to devices for lighting lamps of railway cars and consists in what is termed a spark point holder of refractory and non-conducting material through two holes in which the sparking points on the ends of two platinum wires, for example, pass. Devices are also described for protecting the sparking points from the heat. 8 claims.

4,179. "Improvements in electric road vehicles actuated by electricity." T. Machin. Dated February 25th, 1896. Consists in an arrangement of a cradle mounted on trunnions for carrying the accumulators and a trough shaped channel for holding the wires which conduct the current from the batteries to t e motors. 3 claims.

8,853. "A new or improved construction or arrangement of generator of electricity." Harzt. Dated April 27th, 1896. Relates to an appliance for the generation of electricity without expenditure of heat, mechanical labour, or the application of chemical materials in a purely physical manner as the outcome of terrestrial motive force in the form of two currents. The scope of the invention will be best understood from the claim which is for the application of vacuum chambers consisting of several cells each with a vacuum in a vacuum, and a vacuum over a vacuum for the purpose of effecting the conversion of power (conversion of the natural atmospheric pressure, or, by means of a mantle and suitable contrivances for pressure, of artificially increased air, gas, or hydraulic pressure) into electric fluid, 3 claims.

12,250. "Improved plates for secondary galvanic batteries and a method of producing the same." C. Marschner. Dated June 4th, 1896. In making plates consisting entirely of oxides without a lead grid or foundation a solution of amber or other fossil resin in alcohol or other suitable material is employed as a binding agent. 1 claim.

15,129. "A process and apparatus for effecting electrolysis." F. W. Golby. (A communication from O. Arlt.) Dated July 8th, 1896. Electrodes of liquid matter, mercury or molten metal for example, are provided which flow through the electrolyte in such a manner as to be divided into jets or sprays. The fluid electrode is continually supplied so that the circuit is never interrupted. 1 claim.

18,656. "An electric traction system." S. P. Thompson and M. Walker. Dated September 3rd, 1896. Relates to a system of electric traction in which the electric current is supplied to the cars from studs laid in the road, each of such studs being in turn connected to a main conductor by means of an automatic switch when the car is above or near it, and disconnected when the car has left. 9 claims.

19,301. "Improvements in storage batteries." A Preiss. Dated September 1st, 1896. The negative pole of the cell is formed of a thin sheet of suitable metal such as zinc or aluminium, preferably a chemically pure metal, the positive pole is an ordinary lead plate. 2 claims.

20,796. "Improvements relating to electric railways." H. H. Lake. (A communication from R. Sundell.) Dated September 19th, 1896. Relates to railways of the kind known as surface trolley lines in which the current is conveyed to the car by sectional conductors placed in the track, which conductors are connected with the mains only when a car travels over them. There are in the system shown three sets of sectional conductors placed in the track which conductors are connected with the mains only when a car travels over them. There are in the system shown three sets of sectional conductors, one set being connected to the positive main, a second set being connected to the negative main while the third set is connected through switching magnets with the track rails. 8 claims.

## ELECTRICAL PATENTS OF 1883 EXPIRING IN APRIL, 1897.

We are informed by Messrs. W. P. Thompson & Co. that about 65 applications for electrical patents were filed in the month of April, 1883. Out of those that were completed only one has been allowed to run its full term, viz., 14 years, and this being of considerable interest, we give a short abstract below.

1,736. "Improvements in dynamo-electric machines of Paccinotti's sort." M. Deprez. Dated April 6th, 1883. In order to place the coils separately on the ring core the iron of the core is made in two parts. The iron of the ring has a greater thickness than usual. The coils are slipped on or passed upon the two parts of which the ring cores are composed, and the two parts are then connected so as to form a whole, which presents no projection and no solution of continuity in a magnetic point of view. The coils can be formed separately by means of moulds. To prevent a part of the space at the outer part of the ring from being lost, two sets of coils different in their form are placed on the ring alternately. 1 claim.